

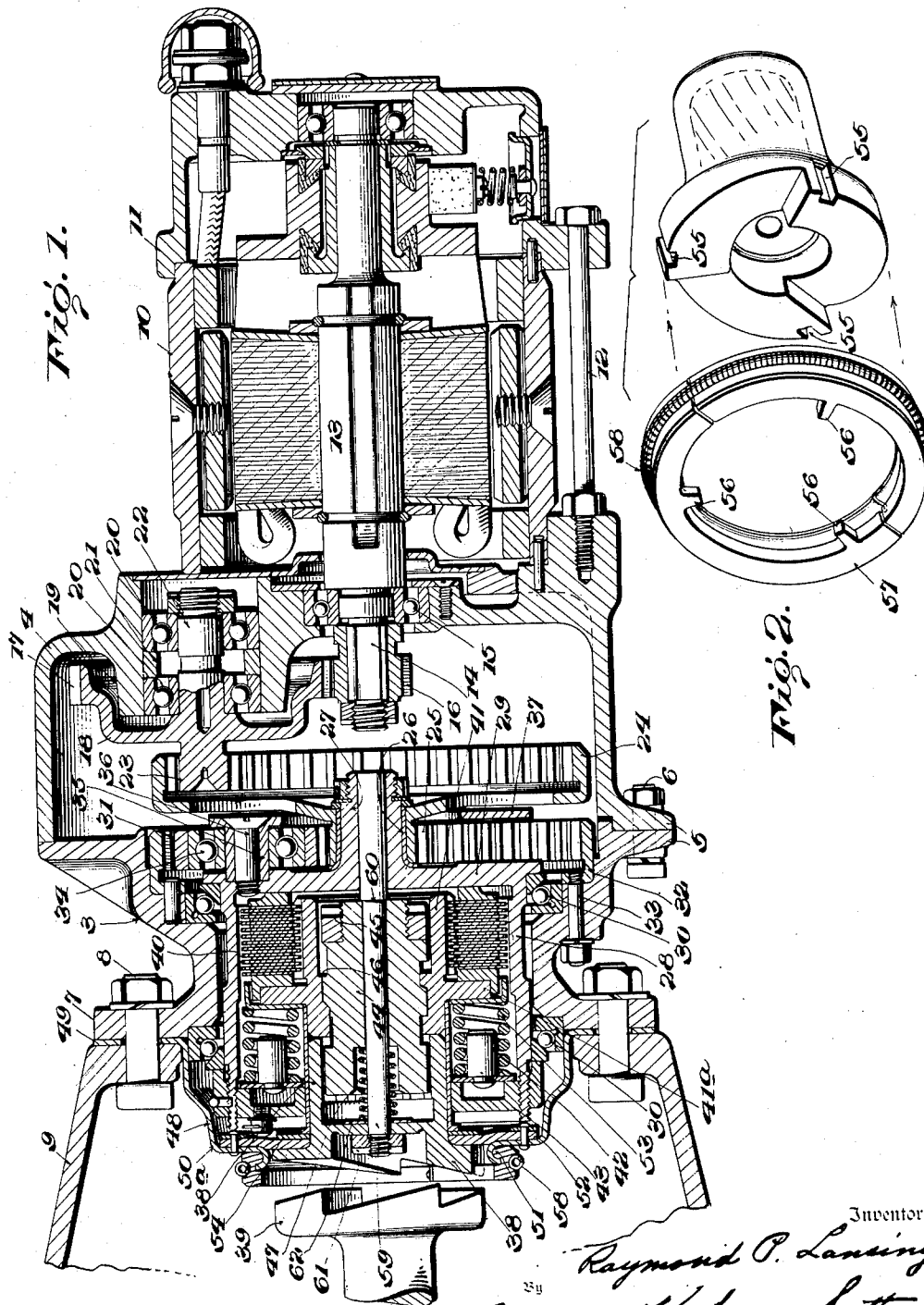
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ENGINE STARTING APPARATUS

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ENGINE STARTING APPARATUS

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This invention relates to engine starting apparatus and more particularly to power means for cranking internal combustion engines.

One of the objects of the invention is to provide a novel electric starter that is symmetrical in form, light in weight, and which is particularly adapted for use in cranking airplane engines.

Another object is to provide a starter of the above type embodying a novel means for drivably connecting the starting apparatus to a member of the engine to be started.

A further object is to provide an electric starter having an engine engaging member and including novel means for automatically moving said engine engaging member into driving engagement with a member of the engine to be started, said novel means being in the nature of an improvement upon the automatic meshing means disclosed and claimed generically in my co-pending application No. 86,414 filed February 6, 1926.

A still further object is to provide a novel electric starter having the armature shaft of the motor disposed substantially coaxially with the engine engaging member and embodying means for rotating the engine engaging member at a much lower speed than that of the armature shaft of the motor.

One embodiment of the present invention is illustrated in the accompanying drawing wherein like reference characters refer to like parts and wherein,

Fig. 1 is an axial sectional view of a starter embodying the present invention; and

Fig. 2 is a perspective view of one form of means which may be employed for insuring automatic meshing of the engine engaging member.

The starter embodies a housing constituted by an inner section 3 and an outer section 4 having suitable flanges 5 to receive bolts 6 for detachably connecting said sections. The inner section 3 is provided with a flange 7 to receive bolts 8 for securing the starter to the crankcase of an engine, a portion of the latter being indicated at 9. Secured to the outer end of section 4 is an electric motor provided with a casing 10 having a flange 11 to receive screws 12 which may be employed for detachably securing the motor to the housing 3, 4.

The motor may be of any suitable type embodying an armature shaft 13 provided with a laterally projecting, reduced portion 14 that is rotatably mounted as by means of a suitable bearing 15 in the end wall of housing section

4. Drivably connected to the reduced portion of the armature shaft is a pinion 16 that meshes with a spur gear 17 which, in the form shown, is formed on the large periphery of a bell-shaped member 18. Extending within the member 18 is a cylindrical member 19 which is preferably formed integrally with the end wall of housing section 4. The member 19 supports therein a pair of bearings 20 that are maintained in spaced relation by means of a ring 21 carried on a lay shaft 22 which is rotatably supported by said bearings and which, in the form of the invention illustrated, is integral with the bell-shaped member 18. Disposed coaxially with respect to shaft 22 and projecting laterally from the small end of member 18 is a pinion 23 adapted to engage an internal gear 24. If desired pinion 23 may be formed integrally with member 18 and shaft 22.

Gear 24 is preferably formed integrally with a small spur gear 25, and the two gears are rotatably mounted as by means of a bushing 26 on a stub shaft 27 that extends outwardly from, and is drivably connected to, a barrel 28 having a closed end 29, the stub shaft being integral with said closed end in the illustrated embodiment of the invention. Ball bearings 30 carried by the inner housing section 3 are preferably employed for rotatably mounting the barrel 28.

Gear 25 constitutes a sun gear for a plurality of planetary gears 31 that are rotatably mounted on the barrel end 29 and mesh with an internal gear 32 which is fixedly mounted within the housing by means of studs 33. Preferably three planetary gears 31 are employed, and one of these is shown in section in Fig. 1. These gears 31 are preferably spaced 120° apart, so that as the view is taken in Fig. 1, one of the gears would appear in elevation just below the stub shaft 27; but in order to avoid confusing the teeth of this second gear 31 with those of the internal gear 32, the former has not been shown. Each of the planetary gears is rotatably mounted by means of a ball bearing 34 carried by a sleeve 35 which is countersunk at its inner end in barrel end 29. Extending through sleeve 35 and threaded into the barrel end 29 is a screw 36 which supports the sleeve, bearing and planetary gear. If desired a retaining ring 37 for bearings 34 may be formed integral with sleeves 35.

The electric motor is adapted to drive an engine engaging member 38 through the train of reduction gearing described above. The member constitutes one element of a jaw clutch, the other

element being formed by a member 39 carried by a rotating part of the engine to be cranked, such as the engine crankshaft or an extension thereof.

5 Normally members 36 and 39 are disengaged, the member 38 being adapted for longitudinal movement into driving engagement with member 39. An appreciable interval elapses between the energization of motor 10 and the engagement
10 of the jaw clutch members. During this time the armature of the electric motor acquires a relatively high speed or rotation and due to its mass a large amount of kinetic energy is stored therein. In order that the parts of the apparatus and
15 particularly the reduction gearing may be made as light as possible, it is desirable to provide yielding means intermediate the train of gearing described above and the engine engaging member 38, whereby the energy stored in the
20 motor armature is ineffective to damage said gearing when the clutch member 38 suddenly engages the stationary engine member 39. For this purpose there is preferably employed a multiple disk clutch embodying a plurality of friction disks 40, a number of said disks being
25 splined to the inner surface of barrel 28, and the remainder being splined to the outer surface of an interiorly threaded nut 41. Resilient means such as a plurality of coil springs 42 and an adjusting nut 43, which is threaded into the
30 inner end of barrel 28, are provided for varying the pressure with which disks 40 are maintained in engagement.

Mounted for rotary and longitudinal movement within nut 41 is a threaded shaft 44 which
35 is longitudinally splined at its inner end to drivably engage a correspondingly splined, tubular and outwardly extending portion 38a of the jaw clutch member 38. Movement of threaded
40 shaft 44 to the left, as viewed in Fig. 1, relative to nut 41 is positively limited by means of a member 45 threaded on the outer end of shaft 44 and constituting a stop shoulder for engagement with a shoulder 46 formed interiorly of
45 nut 41. Preferably a coil spring 47 is interposed between jaw clutch member 38 and shaft 44, a portion of said spring extending into a recess formed in the inner end of the shaft, to yieldingly resist relative movement of the clutch
50 member towards the shaft.

The starter is preferably provided with oil sealing means for preventing oil in the engine crankcase 9 from seeping into the starter housing. For this purpose there is fitted over the
55 inner end of the starter a cup-shaped member 48 that is preferably formed of metal and is provided with a flange 49 on the outer end thereof, said flange being adapted to be clamped between flange 7 of the starter housing and the
60 engine crankcase. The inner portion of member 48 is bent inwardly toward jaw member 38, as at 50, and is provided with a central opening which is slightly larger in diameter than the outer diameter of the head of jaw member 38. Preferably member 48 is strengthened adjacent said
65 opening by being bent or curved as at 51.

In order to prevent seepage of oil through the central opening in member 48, the latter preferably carries a washer 52 that may be formed
70 of leather and is secured in any suitable manner to the shoulder provided adjacent the bend 50 of member 48. Normally the inner portion of washer 52 is held in engagement with the adjacent surface of the head of jaw member 38
75 by means of a sleeve 53 which slidably sur-

rounds the cylindrical portion 38a of the jaw clutch member and abuts at its outer end against a flange 41a provided on nut 41. If desired a metal ring 54 may be interposed between the
80 inner end of sleeve 53 and the adjacent face of washer 52. The above described oil seal means is not claimed per se in this application as it constitutes the subject matter of claims in my co-pending application No. 682,350 filed
85 July 26, 1933.

Means are provided for moving jaw clutch member 38 into driving engagement with the engine member 39, and preferably said means are so constituted as to be automatic in operation. To this end the outer periphery of the
90 head of member 38 is provided with three longitudinally disposed slots 55 (Fig. 2) which are preferably spaced at intervals of 120° and which are adapted to receive radial lugs 56 which project inwardly from the inner surface of a split-
95 ring 57 that is supported on the curved lip 51 of the oil seal member 48. The two portions of the split-ring 57 are preferably retained in position on member 48 by means of a surrounding
100 resilient member, such as a coil spring 58 which rests in an annular groove formed in the outer periphery of said ring 57. The latter is adapted to rotate on the curved lip surrounding the central opening in member 48.

As will be pointed out more fully hereafter,
105 it is desirable for shaft 44 and jaw clutch member 38 to have relative longitudinal movement but these elements must rotate in unison. For this purpose the two parts are splined together as previously described. It is also desirable
110 to provide means for retaining these parts in operative relationship in order that the driving connection between the same may not be interrupted due to excessive relative longitudinal movement thereof. For this purpose there is
115 provided a rod 59 which slidably extends through stub shaft 27, barrel end 29, threaded shaft 44 and a central opening in the hub of member 38. The inner portion of rod 59 is of reduced diameter to provide a shoulder 60 which normally abuts against the outer end of shaft
120 44. The inner end of rod 59 is threaded to receive a nut 61 which abuts against the hub of jaw member 38 and coacts with shoulder 60 to retain said member and shaft 44 in operative
125 relationship. Preferably one or more washers 62, which may be formed of flexible material, are carried by rod 59 intermediate the inner end of spring 47 and the hub of jaw member 38 to prevent seepage of oil from the crankcase
130 through the central opening in member 38.

When the motor is energized by closing the circuit thereto from a suitable source of power, rotation of the armature shaft is transmitted
135 through the three-stage reduction gearing illustrated, to barrel 28. Rotation of the latter is yieldingly transmitted through clutch disks 40 to nut 41.

Shaft 44 and jaw clutch member 38 tend to rotate in unison with nut 41, but the rotation
140 of these two members is resisted by ring 57 which has frictional engagement with the curved lip around the central opening in member 48 and slowly rotates thereon. The drag on clutch member 38 resulting from the latter's
145 engagement with the ring 57 is effective to cause shaft 44 to move to the left, as viewed in Fig. 1, compressing spring 47 and yieldingly moving jaw member 38 into full meshing engagement with engine member 39. When the
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jaw clutch members are in complete meshing engagement member 45 abuts against shoulder 46 interiorly of nut 41. Engine member 39, clutch member 38, and shaft 44 now rotate in unison with nut 41. The movement of member 38 is effective through nut 61 to move rod 59 to the left, relative to barrel 28. Spring 47 insures full engagement of the jaw clutch members.

10 The electric motor is now effective to crank the engine, and the inertia of the parts of the latter is gradually overcome. Relative rotation between barrel 28 and jaw member 38 is permitted by the disk clutch during the time that the engine crankshaft is being brought up to the speed of jaw 38.

When the engine starts under its own power the speed of rotation of the crankshaft is greater than that of jaw 38. The inclination of the teeth of jaw members 38 and 39 is now effective to move member 38 to the right out of driving engagement. If the circuit to the motor is still closed at this time jaw member 38 will again be moved into driving engagement but no damage to the parts will result and the engine can never drive the motor armature due to the construction and arrangement of the jaw clutch members. In the event the engine backfires, the disk clutch will yield and no damage to the parts will result.

There is thus provided an electric starter which is compact and symmetrical, and which is particularly adapted for use in cranking airplane engines. The driving connection between the starter and the engine to be cranked is automatically established, but as will be understood by those skilled in the art the invention is not limited to the type of meshing mechanism disclosed. The automatic meshing means may be quickly installed on the oil seal member 48, which latter constitutes, in effect, a portion of the starter housing. The starter is of the self-contained type and is adapted to be removed from and installed on the engine as a unit.

45 The jaw clutch members are normally disengaged and energy is stored in the motor armature prior to the establishment of the driving connection, thereby rendering the cranking operation more certain and decreasing the drain of current on the battery or other source of power. The friction clutch permits the use of relatively light gears, protects the apparatus against backfire, and permits the engine crankshaft to be brought up to speed gradually without a substantial decrease in the speed of the motor armature. While the gear train illustrated is of the three-stage reduction type, it will be understood that various changes may be made therein, and in the form and arrangement of the other elements of the apparatus. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In starting apparatus for an internal combustion engine, an engine engaging jaw clutch member, a prime mover for rotating said clutch member, means for drivably connecting said power means and clutch member, oil sealing means for said apparatus, and means including a member rotatably supported by said oil sealing means and having engagement with said clutch member for moving the latter into engine engaging position.

2. In a self-contained starter of the type embodying an engaging jaw clutch member means

including reduction gearing for rotating said engine engaging member, oil seal means for the starter, and means for moving said first named member into driving engagement with said engine member, said means including a restraining member yieldably mounted on a part of said oil seal means and operatively engaging said first named member to retard its rotation.

3. In starting apparatus of the type embodying an engine engaging jaw clutch member, automatic means having engagement with said jaw clutch member for moving the latter into engagement with a member of the engine to be started, said automatic means including a ring adapted to rotate with said clutch member.

4. In apparatus of the class described, a rotary and longitudinally movable engine engaging jaw clutch member, and means for automatically moving said jaw clutch member into driving engagement with said engine member, said means including a ring provided with lugs adapted to engage the jaw clutch member.

5. In an engine starter of the type embodying an engine engaging jaw clutch member, the combination with said jaw clutch member of means for moving said jaw clutch member into driving engagement with said engine member including a split ring carried by said oil sealing means, and having lugs engaging the jaw clutch member and a spring for holding the split ring in frictional engagement with the oil sealing means.

6. In an engine starter of the type embodying a housing, an engine engaging jaw clutch member mounted in said housing, automatic means for longitudinally moving said jaw clutch member into driving engagement with said engine member including a split ring carried by the housing and having lugs engaging the jaw clutch member, a circumferential groove on said ring and a toroidal spring within the groove and surrounding the split ring for holding the same in frictional engagement with the housing.

7. In an engine starter of the type embodying a housing, an engine engaging jaw clutch member mounted in said housing, means for moving said jaw clutch member into driving engagement with the engine member including a split-ring provided with inwardly extending lugs adapted for sliding engagement with said jaw clutch member, and yielding means surrounding said split-ring.

8. In apparatus of the class described, an engine engaging jaw clutch member, means for actuating said jaw clutch member, the latter being provided with a plurality of longitudinally extending grooves, and means for moving said jaw clutch member to driving position including a rotatable member having lugs extending into the longitudinal grooves of said clutch member.

9. In an engine starter the combination of a longitudinally movable engine engaging member, means for moving the engine engaging member to engaged position including a multi-part ring having a portion in sliding engagement with the engine engaging member and yielding means for restraining the multi-part ring from free rotational movement on its mounting.

10. In an engine starter, the combination of a longitudinally movable engine engaging member, a closure member surrounding the engine engaging member and provided with a curved lip, and means for moving the engine engaging member to engaged position including a multi-part ring having a portion in sliding engagement with the

engine engaging member, and yielding means for retaining the multi-part ring in frictional engagement with said curved lip.

11. In starting apparatus of the type embodying an engine engaging jaw clutch member, automatic means having engagement with said jaw clutch member for moving the latter into engagement with a member of the engine to be started, said automatic means including a ring adapted to rotate with said clutch member, and means for exerting an inwardly directed pressure on said ring.

12. In apparatus of the class described, a substantially cylindrical clutch member having a series of teeth on its forward end surface and a second series of teeth disposed about its lateral surface, and means for moving said clutch member to driving position including a yieldably held rotatable member having teeth meshing with the laterally disposed teeth on said clutch member.

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