April 16, 1929. R. P. LANSING 1,709,586

ENGINE STARTER

Filed Sept. 29, 1926 2 Sheets-Sheet 1

Fig. 1.

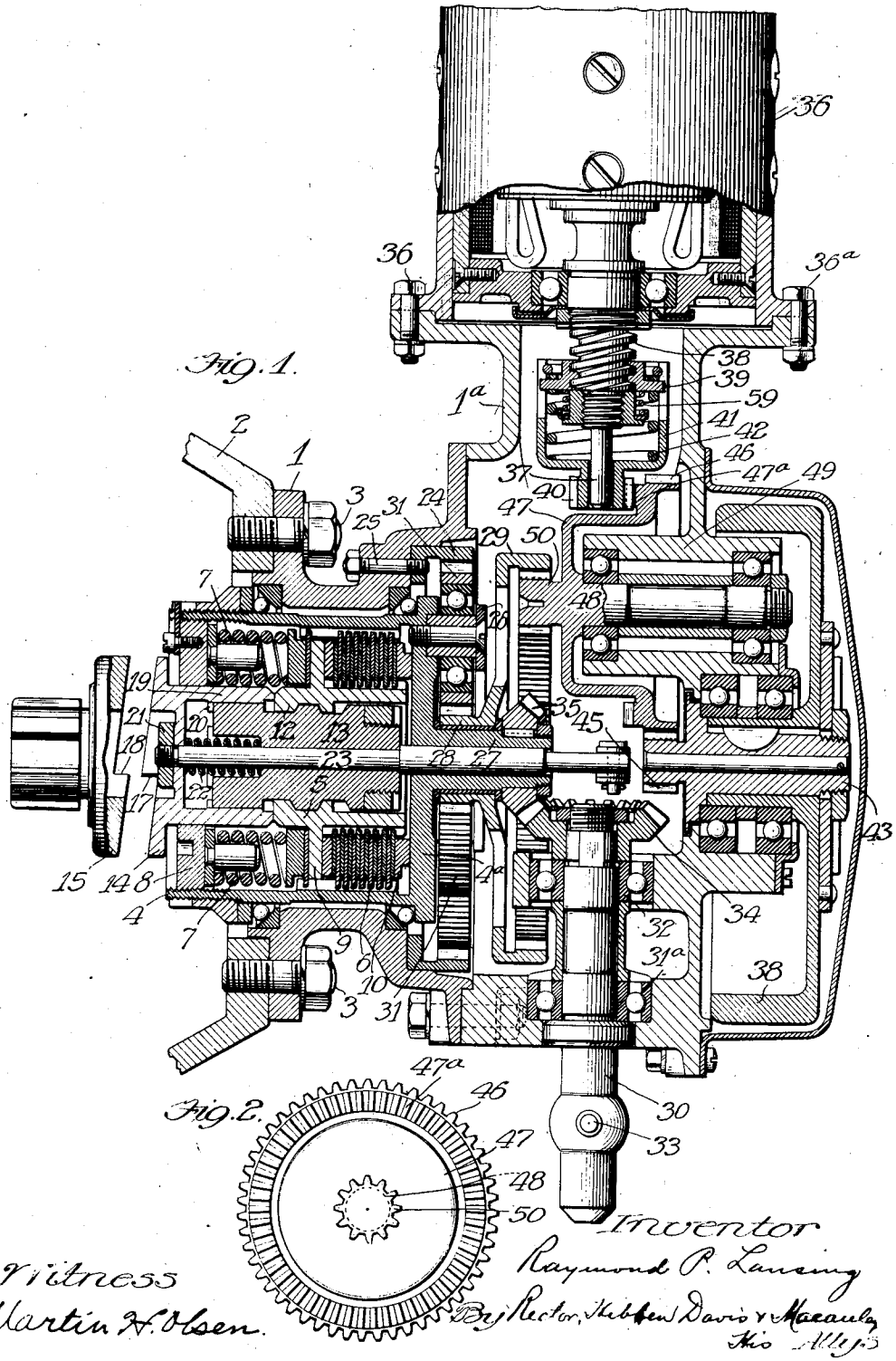

Fig. 2.

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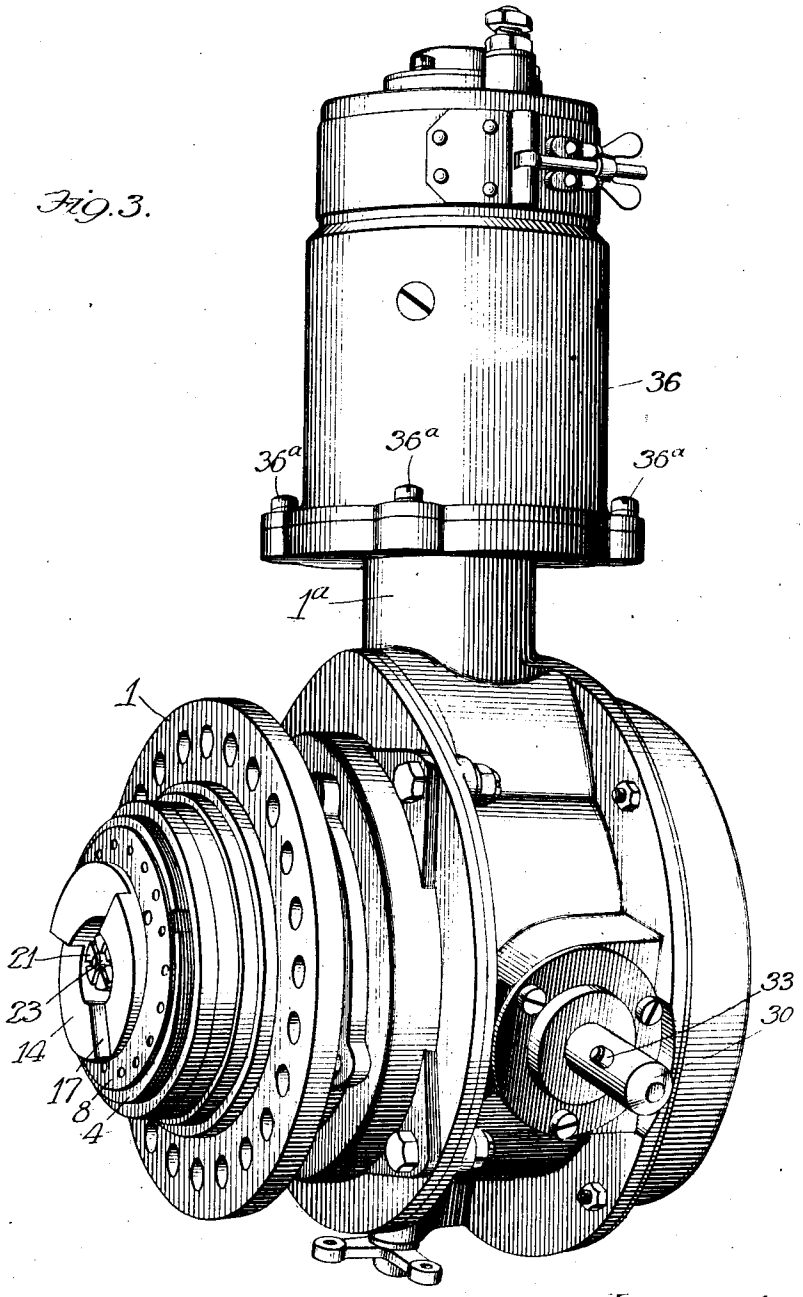
Fig. 3.



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UNITED STATES PATENT OFFICE.

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ENGINE STARTER.

Application filed September 29, 1926. Serial No. 138,558.

My invention relates to engine starting apparatus for the starting of engines such as internal combustion engines, and more particularly but not necessarily airplane engines, and the object thereof is to provide a simple, efficient and reliable apparatus capable of either manual or power operation or both and characterized also by the provision of simple and efficient inertia means actuated by such power or manual means for the accumulation and storage of energy which is thereupon utilized by the application thereof to the engine for cranking the same. Speaking more specifically, the main object of my invention is to provide the power means, such as an electric motor, with a connecting means which is automatically connectable with and disconnectable from a certain part of the reduction gearing which is associated with the inertia means, such as a flywheel. The construction and arrangement is such that a variable ratio between the armature of the motor and the flywheel is permitted instead of the necessity of a one to one ratio. My invention also provides for the ready application to and removal from the starting apparatus of the electric motor which is disposed at an angle to such apparatus, in the present instance at a ninety degree angle.

In the drawing, Figure 1 is a section of an apparatus embodying my invention; Fig. 2 an end view of the bell gear of the reduction gearing; and Fig. 3 a perspective of the apparatus.

My apparatus comprises a transmission or drive having an element hereinafter designated a driving member adapted to engage and crank a member of the engine to be started, reduction means such as gearing, and inertia means such as a flywheel, and means for actuating such drive, gearing and flywheel. In the present instance I have shown two such actuating or driving means, to wit: power means, such as an electric motor, and manual means including a crank shaft, either one of which two means may be dispensed with and removed from the apparatus if desired, though I prefer the complete apparatus as hereinafter illustrated, that is, with both the power means and the manual means employed. For the purpose of a clear and accurate description of my invention and for convenience, I will describe my apparatus as used in connection with airplane engines although it will be understood that the same is not limited thereto in its application and, moreover, I will describe my invention in connection with the particular form of transmission or drive illustrated, which particular construction is suitable but not essential for the carrying out of my invention.

First describing the transmission or drive, the same is located within a main casing 1 which is suitably supported as by being detachably connected with the crankcase 2 of the engine as by means of bolts 3, a small portion of which crankcase is illustrated. Within the casing, there rotates a driving barrel 4 and a nut 5 located and operating concentrically therewithin and operatively connected with the barrel by a yieldable driving connection which is here in the form of a friction clutch 6. This clutch is composed of two sets of disks which are splined respectively to the interior of the barrel and to a right-hand extension (Fig. 1) of the nut. The proper pressure for the disks is provided by a series of springs 7 located within the barrel and such pressure is regulated by the adjustable ring 8 screwing in the interior of the barrel. The thrust of these springs is against the flange 9 of nut 5 and tends to force such nut inwardly and consequently force the clutch disks against the spacing ring 10 and into frictional contact with each other.

The nut 5 is provided with internal long lead threads 12 in which is threaded a screw shaft 13 constituting the main portion of the driving member whose other principal portion is a clutch member 14 adapted to engage a member of the engine to be started, such as the corresponding clutch member 15 forming a part of or secured to a rotatable part of the engine. The element 14 is in the form of a disk having clutch jaws 17 adapted to engage complementary clutch jaws 18 on the engine member and provided with a hub or sleeve portion 19 which is splined to the outer end of the screw shaft by means of splines 20, whereby element 14 and screw shaft 13 have a relative longitudinal movement of limited degree independent of each other.

The element 14 is held in outward position with a yielding pressure in suitable manner as by means of a coil spring 22 which bears at its outer end against the bottom of sleeve 19 and at its inner end against the bottom of a socket formed in the outer end of the screw shaft. The outward movement of element 14 is limited by the head or nut 21

on the outer or left-hand end of an operating rod 23 which passes centrally through the driving parts and centrally through the reduction gearing hereinafter described.

Next referring to the reduction means, the same is in the form of gearing contained within a second casing 1^a by which such gearing is supported and in which it has its bearings. A stationary internal gear 24 is secured to casing 1 in suitable manner as by screws 25 and with the same there meshes a series of three planetary gears 31. These gears are journaled between the end plate 4^a and a plate 26 parallel therewith. This end plate 4^a has a hub 27 extending laterally to the right in Fig. 1 and on the same there is loosely mounted a hub 28 of the internal gear 29. This reduction gearing is operatively connected respectively with the manual means and with the power means in the following manner:

Referring to the manual means, the same comprises a cranking shaft 30 entering through one side of the casing 1 and having suitable bearings 31^a and 32 therein. This shaft is provided with suitable means, such as the pins 33, for engagement with an ordinary hand crank. At its inner end, the cranking shaft is provided with a bevel pinion 34 secured thereto and meshing with a corresponding bevel pinion 35 which is secured to the hub 27 of the barrel 4.

Next referring to the inertia means, the same consists of a flywheel 38 which has a central hub keyed and splined to a central shaft 43 which is here in alignment or tandem relation with the axis of the driving member of the transmission. This shaft is provided at its left-hand end with a pinion 45 which meshes with peripheral gear teeth 46 of the bell gear 47 whose central shaft 48 is mounted within the bearing 49 of the casing 1^a. This bell gear 47 is provided at one end with a pinion 50 which meshes with the internal gear 29.

Next referring to the power means or electric motor and its operating connections, the electric motor 36 is removably secured by means of the bolts 36^a to the upper extension of the casing 1^a. The armature shaft 37 of this motor is extended and provided with a screw threaded portion 38. On this extended armature shaft there is mounted the automatic engaging and disengaging device which here comprises a control member or nut 39 and a pinion 40 which is operatively connected with the nut 39 and controlled in its movements and driven thereby through the medium of a barrel 41. This barrel and nut are held in yielding extended position by means of a coiled spring 42, such barrel being splined at its upper end to the nut 39. The pinion 40 meshes with an integral crown gear 47^a on the bell gear 47, which constitutes an intermediate member of the reduction means, and is adapted to rotate the latter. In addition to the main spring 42 which permits the pinion 40 to have longitudinal endwise movement in case of abutting of its teeth with the gear teeth 47^a, an additional spring 59 is provided in order to hold the device or shift in its out of mesh position.

The rod 23 is adapted to be manually operated by suitable connections extending through the side of the casing 1^a, not shown.

Describing a cycle of operation and beginning with the parts in their normal position shown in Fig. 1, except that the pinion 40 is here in its engaged position, and first describing such operation when the electric motor is employed as the starting means for the flywheel and the drive, when the motor is energized the automatic connection between its armature shaft and the bell gear will be automatically advanced so as to bring the pinion 40 into mesh with the crown gear 47^a and the reduction gearing as well as the flywheel will be rapidly rotated and the torque will be transmitted to the drive or transmission including the screw shaft 13. However, this shaft will now be merely rotated and will not be advanced as its rotation is comparatively slow because of the reduction gearing. When the flywheel rotation has reached the predetermined degree the current may or may not be cut off from the electric motor as desired by the operator but the rod is now operated by being thrust to the left as in Fig. 1 with the result that the screw shaft 13 will be caused by such pressure and by automatic action between its screw threads and those of the nut 5 to be advanced, thereby bringing the clutch jaws 17 and 18 into engagement. The engine member will thereby be rotated and the engine will be cranked. When the engine operates under its own power the driving member will be automatically disengaged through the screw action between the screw shaft 13 and the nut 5 and also the inclined formation of the clutch jaws.

Next describing a cycle of operation when the manual means is the source of power, when the cranking shaft 30 is rotated by an ordinary hand crank the bevel gear 34 will be rotated and thereby the bevel gear 35 and hub 37 and entire barrel 24 of the drive. At the same time the planetary gears will cause rotation of the internal gear 29 which in turn will operate the transmission gearing composed of the pinion 50, gear 47, pinion 45 and shaft 43, with the result that the flywheel 38 will be rapidly rotated. At this time the electric motor is disconnected inasmuch as the automatic connecting device is normally in disconnected position and inasmuch as when the motor is deenergized at the beginning of the cranking operation the continued rotation of the flywheel and the reduction gearing will automatically disengage said device and cause it to assume its normal position

which, as stated, is a position of non-engagement with the bell gear. Still describing the manual operation, when the desired or predetermined R. P. M. of the flywheel is reached, the operator will actuate the rod 23 in the manner and with the result hereinbefore explained in the case of the use of the motor as the actuating means.

The above described apparatus provides a very compact form of electric inertia starter of the vertical form and the connecting device on the extended armature shaft serves not only as the automatic connection and disconnection between the armature and the gearing of the apparatus but furnishes an advantageous ninety degree gear drive as well and, moreover, permits of a variable ratio between the armature and the flywheel.

I claim:

1. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started, axially fixed reduction means operatively connected with the drive, a motor, and motion transmitting means operatively associated with the motor and adapted to directly engage an element of the reduction means, said motion transmitting means being normally disconnected from said element.

2. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started, axially fixed reduction means operatively connected with the drive, a motor, and operating connections between the motor and an intermediate member of the reduction means, said connections being normally disengaged therefrom but adapted to be automatically engaged therewith when the motor is operated.

3. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started and means for controlling the cranking engagement and disengagement of said driving member, reduction means operatively connected with the drive, a motor, and automatically engaging and disengaging means between the motor and an intermediate member of the reduction means.

4. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started and means to control such engagement, a reduction gearing operatively connected with the drive, a motor, and operating connections between the motor and reduction gearing including a pinion normally disengaged from such reduction gearing but adapted to be automatically engaged therewith as an incident to the operation of the motor.

5. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started and means to control such engagement, constantly-meshed reduction gearing operatively connected with the drive, a motor, and operating connections between the motor and reduction gearing including a pinion normally disengaged from such reduction gearing but adapted to be automatically engaged therewith as an incident to the operation of the motor and to be automatically disengaged as an incident to the operation of the engine.

6. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started, reduction gearing operatively connected with said drive and including an internal gear, a driving gear having a peripheral gear, a crown gear and also a central pinion which meshes with the internal gear, an inertia device including a pinion meshing with said peripheral gear, and a motor operatively connectable with said crown gear.

7. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started, reduction gearing operatively connected with said drive and including an internal gear, a driving gear having a peripheral gear, a crown gear and also a central pinion which meshes with the internal gear, an inertia device including a pinion meshing with said peripheral gear, an electric motor having an armature shaft, and a connecting device for automatically connecting the motor with said crown gear.

8. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started, reduction gearing operatively connected with said drive and including an internal gear, a driving gear having a peripheral gear, a crown gear and also a central pinion which meshes with the internal gear, an inertia device including a pinion meshing with said peripheral gear and an electric motor having an armature shaft, and a pinion mounted for automatic longitudinal movement thereon to mesh with said crown gear when the motor is enregized.

9. An engine starter including a drive having a driving member adapted to engage and crank a member of the engine to be started, reduction gearing operatively connected with said drive and including an internal gear, a driving gear having a peripheral gear, a crown gear and also a central pinion which meshes with the internal gear, an inertia device including a pinion meshing with said peripheral gear, an electric motor disposed at an angle to the axis of rotation of said driving gear and having an armature shaft, and a connecting device controlled and driven by the motor and adapted to engage and drive said driving gear when the motor is energized.

10. An engine starter including a drive having a driving member adapted to engage

and crank a member of the engine to be started, reduction gearing operatively connected with said drive and including an internal gear, a driving gear having a peripheral gear, a crown gear and also a central pinion which meshes with the internal gear, an inertia device including a pinion meshing with said peripheral gear, an electric motor having an armature shaft disposed at an angle to the axis of rotation of said driving gear, and an automatic engaging and disengaging device carried by said armature shaft and adapted to engage and drive the driving gear when the motor is energized and to be automatically disengaged when the motor is deenergized.

11. An engine starter including a drive having a centrally located driving member adapted to engage and crank a member of an engine to be started, reduction gearing operatively connected with said drive, a casing in which such drive and gearing are mounted and contained and which has bearing hubs, a flywheel bearing in one of said hubs of the casing, said reduction gearing including an internal gear, a driving gear in the form of a bell with a peripheral gear and a central pinion which meshes with the internal gear, said driving gear bearing in the other one of said hubs of the casing, a shaft connected with said flywheel and having a pinion meshing with said peripheral gear, and an electric motor adapted to be operatively connected with said driving gear.

12. An engine starter including a drive having a centrally located driving member adapted to engage and crank a member of an engine to be started, reduction gearing operatively connected with said drive, a casing in which such drive and gearing are mounted and contained and which has bearing hubs, a flywheel bearing in one of said hubs of the casing, said reduction gearing including an internal gear, a driving gear in the form of a bell with a peripheral gear and a central pinion which meshes with the internal gear, said driving gear bearing in the other one of said hubs of the casing, a shaft connected with said flywheel and having a pinion meshing with said peripheral gear, and an electric motor adapted to be operatively connected with said driving gear, said motor being normally disconnected therefrom but adapted to be automatically connected therewith when the motor is energized.

13. An engine starter including a drive having a centrally located driving member adapted to engage and crank a member of an engine to be started, reduction gearing operatively connected with said drive, a casing in which such drive and gearing are mounted and contained and which has bearing hubs, a flywheel bearing in one of said hubs of the casing, said reduction gearing including an internal gear, a driving gear in the form of a bell with a peripheral gear and a central pinion which meshes with the internal gear, said driving gear bearing in the other one of said hubs of the casing, a shaft connected with said flywheel and having a pinion meshing with said peripheral gear, and an electric motor adapted to be operatively connected with said driving gear, said motor being detachably connected with said casing.

14. An engine starter including a drive having a centrally located driving member adapted to engage and crank a member of an engine to be started, reduction gearing operatively connected with said drive, a casing in which such drive and gearing are mounted and contained and which has bearing hubs, a flywheel bearing in one of said hubs of the casing, said reduction gearing including an internal gear, a driving gear in the form of a bell with a peripheral gear and a central pinion which meshes with the internal gear, said driving gear bearing in the other one of said hubs of the casing, a shaft connected with said flywheel and having a pinion meshing with said peripheral gear, and an electric motor adapted to be operatively connected with said driving gear, and including an armature shaft extending into said casing, and an automatic engaging and disengaging device mounted on said shaft and adapted to engage and drive said driving gear.

15. An engine starter including a drive having a centrally located driving member adapted to engage and crank a member of an engine to be started, reduction gearing operatively connected with said drive, a casing in which such drive and gearing are mounted and contained and which has bearing hubs, a flywheel bearing in one of said hubs of the casing, said reduction gearing including an internal gear, a driving gear in the form of a bell with a peripheral gear and a central pinion which meshes with the internal gear, said driving gear bearing in the other one of said hubs of the casing, a shaft connected with said flywheel and having a pinion meshing with said peripheral gear, and an electric motor adapted to be operatively connected with said driving gear, said driving gear having a crown gear with which said motor engages.

16. An engine starter including a drive having a centrally located driving member adapted to engage and crank a member of an engine to be started, reduction gearing operatively connected with said drive, a casing in which such drive and gearing are mounted and contained and which has bearing hubs, a flywheel bearing in one of said hubs of the casing, said reduction gearing including an internal gear, a driving gear in the form of a bell with a peripheral gear and a central pinion which meshes with the internal

said driving gear bearing in the other one of said hubs of the casing, a shaft connected with said flywheel and having a pinion meshing with said peripheral gear, and an electric motor adapted to be operatively connected with said driving gear, said motor having an automatic engaging and disengaging device in the form of a pinion controlled and driven thereby, and said driving gear having a crown gear with which said pinion engages.

In testimony whereof, I have subscribed my name.

RAYMOND P. LANSING.