

Feb. 18, 1936.

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2,030,882

ENGINE STARTING APPARATUS

Original Filed Jan. 8, 1929 2 Sheets-Sheet 1

Fig. 1.

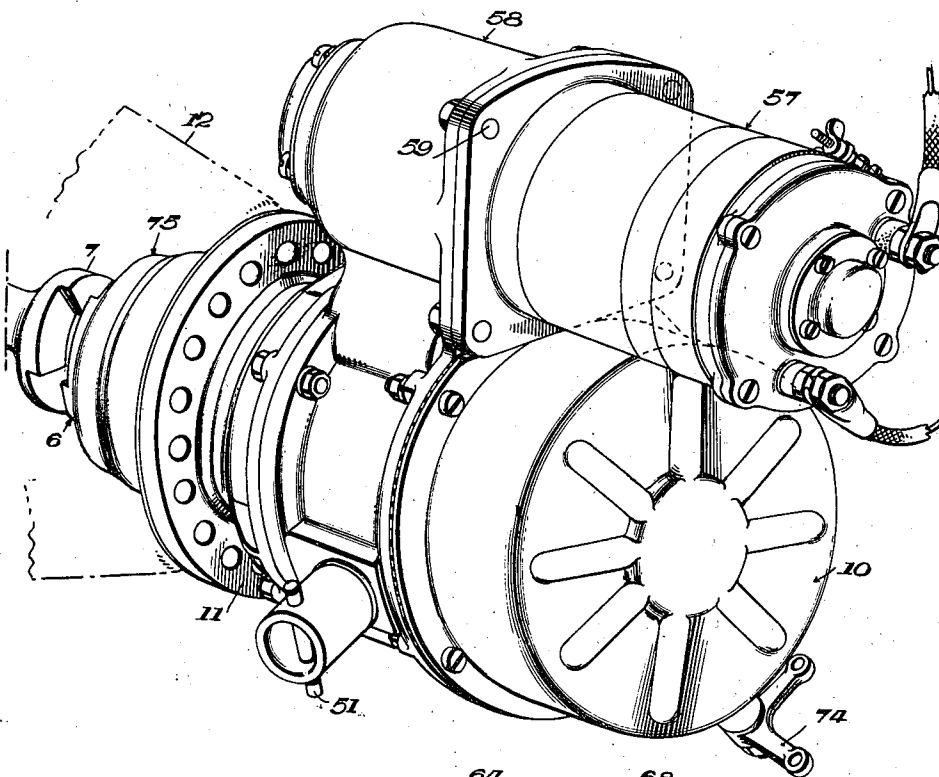
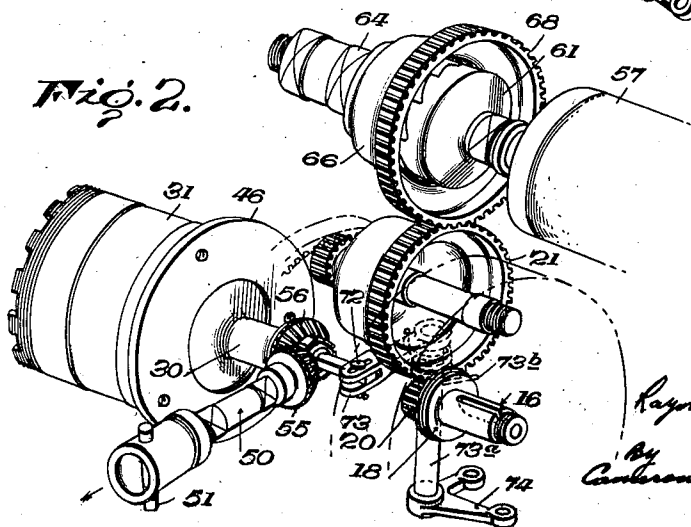


Fig. 2.



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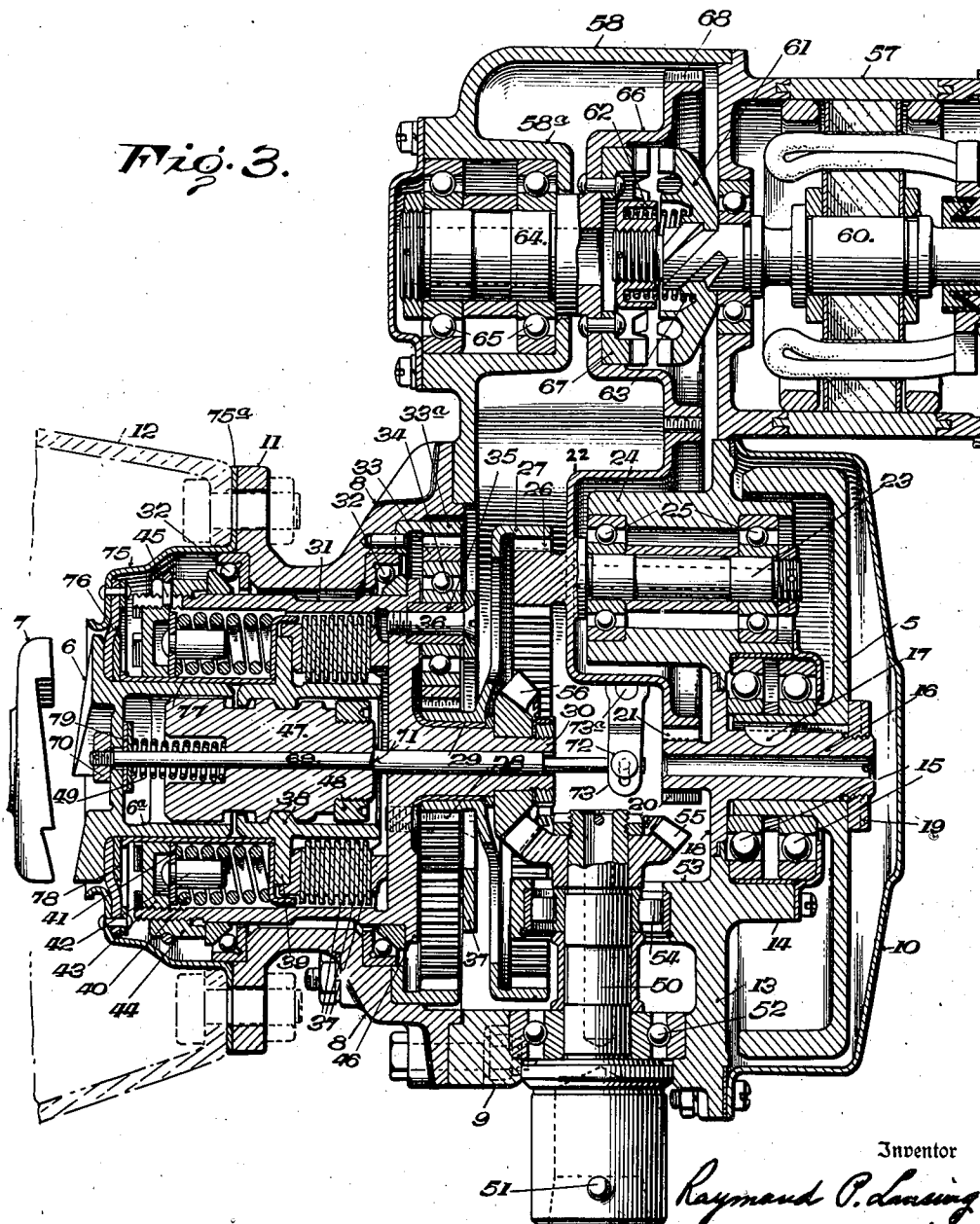
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UNITED STATES PATENT OFFICE

2,030,882

ENGINE STARTING APPARATUS

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Application January 8, 1929, Serial No. 331,093

Renewed May 28, 1935

3 Claims. (Cl. 123-179)

This invention relates to engine starters, and more particularly to a starter of the inertia type.

It is desirable that engine starters, and particularly those employed on aircraft engines, be compact, light in weight, and symmetrical in form. It is further desirable to provide both power and manual means for energizing the starter, the manual means being operable independently of the power means or conjointly therewith under certain conditions.

One of the objects of the present invention is to provide a novel engine starter of the inertia or flywheel type embodying power means and manually operable means for storing energy in the flywheel, the mechanism being so constructed as to be compact, light in weight, and symmetrical in form.

Another object is to provide a novel flywheel starter in combination with a motor for rotating the flywheel, the motor having the longitudinal axis thereof disposed substantially parallel to the axis of rotation of the flywheel and laterally spaced therefrom whereby the length of the structure is materially reduced without excessive increase in the transverse dimensions thereof.

A further object is to provide novel starting mechanism embodying a longitudinally movable engine engaging member disposed coaxially relative to a flywheel for actuating the member, and a motor having its longitudinal axis disposed substantially parallel to the axis of rotation of the flywheel but laterally spaced therefrom for storing energy in the flywheel.

A still further object is to provide novel starting mechanism of the above character which embodies manually operable means for rotating the flywheel, said manually operable means being adapted for actuation independently of the power means or for conjoint action.

Another object is to provide novel inertia starting mechanism of the type wherein the flywheel is disposed substantially coaxially with the engine engaging member and wherein both power and manual means are provided for rotating the flywheel, the power means having its longitudinal axis disposed substantially parallel to the flywheel but laterally spaced therefrom, and the manual means being angularly adjustable relative to the power means.

One embodiment of the invention is illustrated in the accompanying drawings, wherein like reference characters refer to like parts throughout the several views.

In the drawings:

Fig. 1 is a perspective view of mechanism embodying the present invention;

Fig. 2 is a detail perspective view illustrating more particularly a portion of the gearing that is preferably employed in the structure shown in Fig. 1;

Fig. 3 is an axial sectional view of the mechanism shown in Fig. 1.

Referring to Figs. 1 to 3 inclusive, the starting mechanism therein shown comprises a flywheel adapted to rotate an engine engaging member or clutch jaw 6 which is movable into driving engagement with a jaw member 7 provided on an engine crankshaft (not shown), or an extension thereof. The starting apparatus includes a housing constituted by an inner section 8, an intermediate section 9 and a flywheel cover section 10, the sections being removably secured together in any suitable manner and the inner section being provided with a flange 11 to facilitate mounting of the starter on the crank case a portion of which is diagrammatically shown at 12.

The intermediate housing section 9 is provided adjacent the outer end thereof with an irregularly shaped wall or diaphragm 13 having a boss 14 formed centrally thereof to receive the flywheel 5.

The flywheel is adapted to be rotated at high speed in order that sufficient energy may be stored therein for cranking the engine, and a gear train is preferably provided for transmitting the energy stored in the flywheel to the engine engaging member 6, the gear train being so constituted that member 6 will be rotated at a much lower speed than that of the flywheel. For this purpose a shaft 16 extends through the hub of the flywheel and is drivably connected thereto as by means of a key 17. The inner end of shaft 16 is provided with a flange 18 which engages wall 13 and coacts with a nut 19 threaded onto the outer end of the shaft and abutting the flywheel to prevent longitudinal movement of the shaft relative to said flywheel. Shaft 16 is provided closely adjacent flange 18 with a pinion 20 that meshes with a spur gear 21 formed on the large end of a bell shaped member 22 that is rotatably mounted as by means of a stub shaft 23 in an elongated boss 24 formed in the wall 13. Ball bearings 25 are preferably provided for rotatably mounting shaft 23.

Formed integrally with the bell shaped member 22 and shaft 23, or rigidly connected thereto in any suitable manner, is a pinion 26 which meshes with a gear, such as an internal spur gear 27, that is coaxially disposed relative to the fly-

wheel 5. Gear 27 is formed integrally with a pinion 28 that is rotatably mounted by means of a bushing 29 on a stub shaft 30 which is formed integrally with, and projects centrally from the closed end of a barrel 31 rotatably mounted in inner housing section 8 by means of ball bearings 32.

Pinion 28 constitutes a sun gear for a plurality of planetary gears 33, one of which is shown in section in Fig. 3. Preferably three planetary gears are employed, the same being spaced at intervals of 120° about the closed end of barrel 31, and said gears mesh with an internal gear 33^a which is rigidly secured in any suitable manner to the inner surface of housing section 8. Each planetary gear is rotatably mounted by means of a ball bearing 34 on a sleeve 35 having the inner end thereof countersunk in the outer face of the closed end of the barrel. A screw 36 extends through the sleeve and is threaded into the end of said barrel. A retaining ring 37 is carried by the outer ends of the screws 36 and constitutes a retaining member for the ball bearings 34 and sleeves 35.

Means are preferably interposed between the gear train described above and the engine engaging member 6 for yieldingly transmitting the energy in the flywheel to the engine crankshaft without damage such as might result if the driving connections were entirely constituted by rigidly connected elements. For this purpose a multiple disc clutch is preferably employed, said clutch being mounted in barrel 31.

As shown, the clutch comprises a plurality of annular disc 37, certain of the discs being splined at their outer peripheries to the inner surface of barrel 31, and the remaining discs being splined at their inner peripheries to the outer surface of an interiorly threaded nut 38 which is provided intermediate its ends with a flange 39. The clutch discs are positioned between flange 39 and the closed end of barrel 31 and adjustable yielding means are provided for holding nut 38 in operative position with respect to the discs and barrel and for varying the frictional engagement of said discs.

In the illustrated embodiment the yielding means comprise a plurality of coil springs 40 which extend longitudinally within the barrel, the outer ends of said springs having operative engagement with the flange 39. A ring 41 provided with a plurality of laterally projecting studs 42, is mounted in the barrel with the studs extending into the coils of the springs whereby the latter are maintained in proper spaced relation. An adjusting nut 43 is threaded into the open end of the barrel and has abutting engagement with the inner face of ring 41. By adjusting the position of nut 43 longitudinally of barrel 31 the compression of springs 40 may be changed to vary the pressure with which the clutch discs or plates 37 are engaged.

Exteriorly threaded onto the inner end of barrel 31 is a retaining ring 44 for the adjacent ball bearing 32. Ring 44 may be locked in position by means of a wire 45, and said ring is adapted to coact with a shoulder 46, provided on the outer end of the barrel and having engagement with the inner race of outer ball bearing 32, to prevent endwise movement of the barrel relative to the inner housing section 8.

Positioned within nut 38 is a threaded shaft 47 adapted for rotary and longitudinal movement relative to the nut. The outer end of said shaft is provided with suitable means such as a

nut 48 adapted to engage a shoulder formed interiorly of member 38 to limit longitudinal movement of the shaft to the left as viewed in Fig. 3. The inner end of shaft 47 is longitudinally splined and extends into the correspondingly splined hub portion 6^a of clutch member 6 whereby these parts have positive driving engagement, but are adapted for relative longitudinal movement. A coil spring 49 which preferably has its outer end extending into a recess in shaft 47 is interposed between said shaft and the jaw member 6, and yieldingly resists movement of the jaw member toward the shaft.

Manually operable means are preferably provided for rotating the flywheel 5 to store energy therein. As shown, said manually operable means includes a cranking shaft 50 which is rotatably mounted in housing section 9 with the outer end thereof projecting exteriorly of said housing and provided with suitable means such as a transverse pin 51 to receive a hand crank (not shown). Shaft 50 is rotatably supported in the plane of the side wall of section 9 by means of a ball bearing 52 and the inner end of said shaft, which extends substantially at right angles to the axis of rotation of flywheel 5, is rotatably supported in a boss 53 provided in wall 13 by means of a roller bearing 54. The inner end of shaft 50 has rigidly connected thereto a bevel gear 55 which meshes with a bevel gear 56 that is drivably connected to the outer end of stub shaft 30.

Power means are also provided for rotating flywheel 5 and said means are adapted for operation independently of the hand cranking means or for coaction therewith. In order to reduce the overall length of the apparatus and at the same time provide a compact, symmetrical arrangement, the power means, which is preferably in the form of an electric motor 57, has its longitudinal axis laterally spaced from and disposed substantially parallel to the axis of rotation of the flywheel, with the inner end of said motor extending inwardly beyond the vertical plane of the flywheel 5.

The starter housing, and preferably the intermediate section 9 thereof, is provided with a laterally projecting portion 58 to which the flanged end of the casing of motor 57 is secured as by means of screws 59. One end of the armature shaft 60 of the motor projects into the casing, formed by the housing portion 58, and is threaded for a portion of its length to receive a clutch member 61 adapted for rotary and longitudinal movement relative to the shaft. The extremity of shaft 60 is preferably of reduced diameter and is threaded to receive a nut 62 which constitutes a retainer for a coil spring 63 that is interposed between said nut and member 61 to normally hold the latter in non-driving position.

A stub shaft 64 is rotatably mounted by means of suitable bearings 65 in a boss 58^a provided in the wall of casing portion 58, said stub shaft being substantially coaxial with armature shaft 60. The end of shaft 64 adjacent clutch member 61 has rigidly connected thereto a bell shaped member 66 within which is secured a clutch member 67 adapted to be engaged and driven by clutch member 61. The periphery of the large end of member 66 is formed as a spur gear 68 which meshes with spur gear 21 to establish a driving connection between clutch member 67 and the flywheel 5.

Means are provided for moving jaw member 6 into engagement with member 7 whereby energy stored in flywheel 5 is effective to crank the en-

gine. In the form shown said means comprises a rod 69 which slidably extends through stub shaft 30, threaded shaft 47, and a central opening in jaw member 6. The inner end of rod 69 carries a nut 70 which engages jaw member 6 and maintains the latter in operative position relative to the threaded shaft 47. The inner portion of rod 69 is of reduced diameter to provide a shoulder 71 which normally engages the outer end of shaft 47. The outer end of rod 69 terminates closely adjacent pinion 20, and is pivotally connected as by means of a pin 72 to the bifurcated end of a lever 73 that is rigidly connected to a rockshaft 73^a which extends through the housing and carries on its outer end a bell crank lever 74 (Fig. 1). Suitable yielding means such as spring 73^b may be employed to hold lever 73 and rod 69 in the position shown in Fig. 3.

Means are preferably provided for preventing oil from seeping from the crank case into the starter housing, since such oil would impair the operation of the apparatus. For this purpose a cup-shaped member 75, which is preferably formed of metal and is provided on its outer end with a flange 75^a adapted to be clamped between flange 11 of the starter housing and the crank case of the engine, is fitted over the inner end of the starter that projects into the crank case. Secured to the member 75 is a flexible guard or disc 76 of annular form, the inner periphery of said guard having engagement with the outer surface of the laterally projecting hub portion 6^a of jaw member 6. A sleeve 77 surrounds and has sliding engagement with hub portion 6^a and extends outwardly into abutting engagement with flange 39. The inner end of sleeve 77 bears against a ring 78 to hold the latter in engagement with the flexible guard 76. The length of sleeve 77 is preferably such that the inner portion of guard 76 is flexed, outwardly into engagement with the adjacent face of the jaw member 6 and seepage of oil into the starter housing at this point is thereby prevented without interference with the longitudinal movement of the jaw member. A pair of washers 79, one of which may be formed of flexible material, is mounted on rod 69 intermediate spring 49 and jaw member 6 to prevent seepage of oil through the central opening in said jaw member.

When it is desired to store energy in the flywheel, preparatory to cranking the engine, the operator engages a hand crank with the outer end of shaft 50 and rotates the latter. This motion is transmitted through the gear train to flywheel 5 whereby the latter is rotated a large number of times for each revolution of shaft 50. Actuation of shaft 50 results in rotation of barrel 31 and all the parts therein with the exception of rod 69 which maintains jaw member 6 out of driving engagement with member 7. Stub shaft 64 and bell shaped member 66 are also rotated but no driving connection to motor 57 is established at this time.

After the flywheel has been brought to the desired speed of rotation, i. e., after sufficient energy for cranking the engine has been stored therein, the operator actuates the bell crank lever 74, as by exerting a pull on a suitable cable connected to said lever, whereupon rod 69 is forced to the left as viewed in Fig. 3. Shoulder 71 forces shaft 47 to the left, the latter having a combined rotary and longitudinal movement due to

its threaded connection with the nut 38, and jaw member 6 is yieldingly moved through spring 49 into full meshing engagement with jaw member 7. The energy of the flywheel is now effective to crank the engine.

When the engine starts under its own power the speed of rotation of clutch member 7 is greater than that of jaw member 6, and the inclined teeth of said jaw members are now effective to move member 6 to the right out of driving engagement. The yielding means associated with the rockshaft 73^a is effective to move rod 69 to normal position when the operator releases bell crank lever 74.

If it is desired to employ motor 57 for energizing flywheel 5, the circuit to said motor is closed whereupon armature shaft 60 is rotated. The member 61 will now be automatically advanced against the tension of spring 63, into driving engagement with the clutch member 67. A driving connection is now established between the motor and flywheel through gear 68, gear 21, and pinion 20 whereby the flywheel is rotated and energy is stored therein. The electric motor may be employed in conjunction with the crankshaft 50 to energize the flywheel as, for example, when it is desired to conserve the electrical energy employed for actuating the motor, or when the supply of electrical energy is low.

What is claimed is:

1. In an engine starter, an engine engaging driving member adapted for longitudinal and rotary movement, a flywheel disposed substantially coaxially with respect to said engine engaging member, means including a bell shaped gear for drivably connecting the flywheel and member, power means for rotating the flywheel, said power means having the longitudinal axis thereof laterally spaced from and substantially parallel to the axis of rotation of the flywheel, means including a second bell shaped gear meshing with said first named gear, for drivably connecting said power means and flywheel, and manually operable means for rotating the flywheel and adapted for independent or conjoint action of said power means.

2. In an engine starter, a housing, a flywheel rotatably mounted in said housing, an engine engaging member, means including a gear train and a friction clutch rotatable at the lowest speed of said gear train for drivably connecting the flywheel and engine engaging member, and means for energizing the flywheel, said last named means including a motor secured to said housing and a pair of inter-engaged bell shaped gears, one of which is aligned with said motor and the other of which constitutes a part of said first named gear train.

3. In an engine starter of the type embodying a flywheel rotatable within the boundaries of a space defined by two parallel planes, a housing for said starter, a motor having the casing thereof removably secured to said housing and having the longitudinal axis thereof extending through said parallel planes and substantially parallel to the axis of rotation of the flywheel, a clutch member drivably connected to said flywheel, and a cooperating clutch member longitudinally movable into engagement with said clutch member to drivably connect the latter with said motor.

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