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ENGINE STARTING MECHANISM

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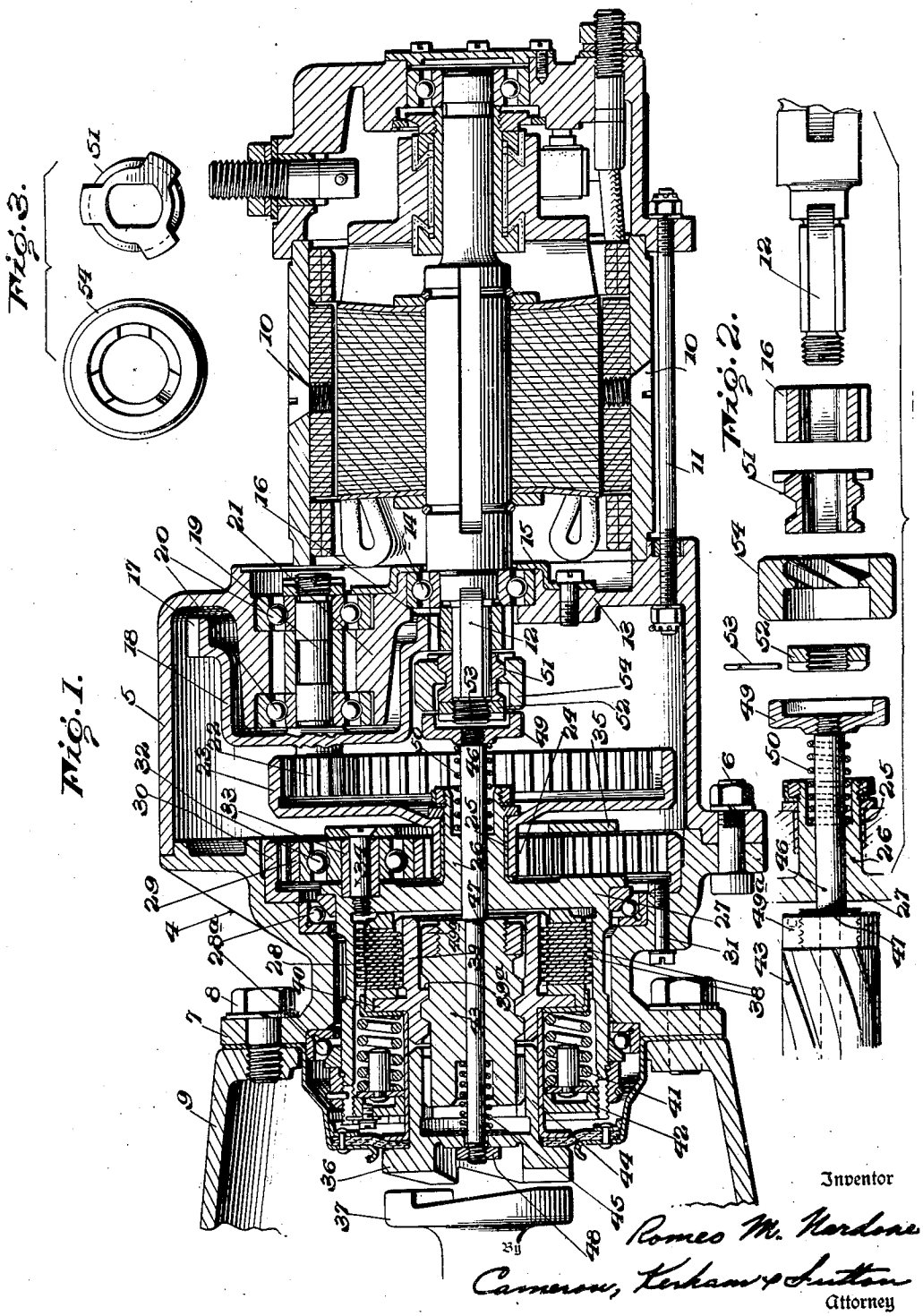


Fig. 1.

Fig. 2.

Fig. 3.

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ENGINE STARTING MECHANISM

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

One of the objects of the present invention is to provide novel starting apparatus of the power actuated type which is so constructed as to be particularly adapted for use in starting aeroplane engines.

Another object is to provide a starter of the above type embodying novel means for moving a rotatable member of the starter into driving engagement with a rotatable member of the engine to be started.

A further object is to provide novel power starting mechanism which is inexpensive to manufacture, which is rugged in construction and which is adapted to be secured to and removed from the engine as a unit.

Another object is to provide novel means for automatically establishing a driving connection between the starting mechanism and the engine to be cranked.

The invention will be readily understood from the following detail description taken in connection with the accompanying drawing wherein like reference characters refer to like parts throughout the several views and wherein—

Fig. 1 is an axial sectional view of one embodiment of the invention;

Fig. 2 is a drawn-out, detail view, partly in section, of the preferred form of the means for automatically establishing a driving connection between the starter and the engine; and

Fig. 3 constitutes a detail showing of two of the elements shown in section in Fig. 2.

The starting mechanism of the present invention includes a cylindrical housing constituted by an inner section 4 and an outer section 5 which are detachably connected by means of bolts 6 which extend through openings in suitable lugs or flanges provided on the adjacent ends of said sections. The inner end of section 4 is provided with a flange 7 through which extend a plurality of screws 8 for removably attaching the housing to the engine crankcase, a portion of the latter being illustrated at 9.

The actuating means for the apparatus is constituted by an electric motor 10 which is removably attached to housing section 5 by means of suitable members such as studs 11. The motor is provided with an armature shaft having a reduced portion 12 which extends through the end wall 13 of housing section 5 and is rotatably supported in said wall by means of a bearing 14 provided with a retainer 15 of any suitable type.

The reduced portion 12 of the armature shaft is longitudinally splined to receive pinion 16 which meshes with a spur gear 17 formed on the large end of a bell-shaped member 18. The latter is rotatably supported by means of a lay shaft 19 and bearings 20 in an enlargement or boss 21 formed on end wall 13. Drivably connected in any suitable manner to bell-shaped member 18 and lay shaft 19 is a pinion 22 which meshes with an internal spur gear 23 that is preferably formed integral with a small gear 24, the gears 23 and 24 being rotatably mounted by means of a bushing 25 on a stub shaft 26 that projects outwardly from the closed end 27 of a barrel 28. Suitable bearings, such as ball bearings 28a are provided for rotatably supporting the barrel.

The small gear 24 constitutes a sun gear for a plurality of planetary gears 29 that are rotatably mounted on barrel end 27 in meshing engagement with an internal spur gear 30 which is rigidly attached to the inner surface of housing section 4 by means of screws 31. Preferably three planetary gears, one of which is shown in section, are employed, said gears being spaced at angular intervals of 120° around the barrel end 27. Each planetary gear is rotatably mounted as by means of a ball bearing 32 and a sleeve 33 which is countersunk at its inner end in barrel end 27. A screw 34, threaded into barrel end 27, extends through sleeve 33 to support the latter, and, if desired, a ring 35 may be carried by the outer ends of the three screws 34 for retaining said sleeves and bearings 32 in operative position.

Barrel 28 is drivably connected to a jaw clutch member 36 which is adapted to be moved longitudinally into driving engagement with a similar jaw clutch member 37 mounted on a rotatable member of the engine to be cranked, such as an engine crankshaft or an extension thereof.

Yielding means are interposed between barrel 28 and jaw clutch member 36 in order to permit relative rotary movement between these members as will be pointed out more fully hereafter. Preferably this yielding means is constituted by a friction clutch embodying a plurality of disks 38, a number of said disks being splined to the inner surface of the barrel and the remaining disks being splined to the outer surface of an interiorly threaded nut 39 provided with a flange 40.

Disks 38 are maintained in frictional engagement at all times between barrel end 27 and flange 40, and resilient means are provided for varying the pressure with which said disks are maintained in engagement. In the form shown, said resilient means are constituted by a plurality of coil springs 41 which have operative engagement at their outer ends with flange 40 and at their inner ends with an adjusting nut 42 that is threaded into the inner end of barrel 28.

Positioned within nut 39 for rotary movement therewith and longitudinal movement thereof is a shaft 43 which is threaded for a portion of its length to engage the threads of nut 39 and is longitudinally splined at its inner end for driving connection with the hollow cylindrical and later-

ally extending portion 44 of jaw clutch member 36. By this arrangement the clutch member 36 is adapted for longitudinal movement relative to shaft 43 but is drivably connected thereto. A coil spring 45 having one end thereof extending into a suitable recess in shaft 43 is interposed between said shaft and the jaw clutch member to yieldingly resist movement of said clutch member toward the shaft. Longitudinal movement of shaft 43 relative to nut 39 is positively limited by means of a stop nut 49*a* carried by said shaft and adapted to engage a shoulder 39*a* formed interiorly of the nut.

Means are provided for moving the jaw clutch member 36 into driving engagement with engine member 37, and preferably said means are so constituted as to be automatic in operation. To this end a rod 46 slidably extends through clutch member 36, shaft 43 and stub shaft 26, the outer end of said rod terminating closely adjacent the end of the armature shaft 12. Intermediate its ends rod 46 is provided with a shoulder 47 which normally is in abutting engagement with the outer end of shaft 43. The inner end of rod 46 is threaded to receive a nut 48 which engages the central portion of the inner face of clutch member 36, said nut coacting with shoulder 47 to limit relative movement between shaft 43 and clutch member 36. The outer end of rod 46 is threaded to receive a disk 49, and in engagement with the disk is a coil spring 50 which surrounds rod 46 and bottoms in a recess formed in the outer end of stub shaft 26.

Means are provided for moving disk 49 and rod 46 to the left to effect the meshing operation of jaw clutch member 36. For this purpose the splined portion 12 of the motor armature shaft carries a sleeve 51 which is exteriorly threaded and is locked in position on the end of said armature shaft as by means of a nut 52 and cotter pin 53. Threaded on sleeve 51 and adapted for rotary movement therewith and longitudinal movement thereof is a rod advance weight 54 which is cylindrical in form and is adapted to engage and longitudinally move disk 49, the weight being limited in its movement relative to sleeve 51 by engagement with nut 52.

When it is desired to crank the engine, the circuit to the motor (not shown) is closed by suitable switch means, whereupon armature shaft 12 is rotated at high speed. This movement is transmitted through the reduction gear train described above to barrel 28, through the friction clutch to nut 39, shaft 43 and jaw clutch member 36. The barrel and all parts therein tend to rotate in unison.

Simultaneously with the energization of the motor, the inertia of the weighted disk 54 is effective to move the latter to the left relative to sleeve 51, whereby said member 54 is given a combined rotary and longitudinal movement into engagement with disk 49 and the latter is forced to the left against the tension of spring 50. This movement of disk 50 is transmitted through rod 46 and shoulder 47 to shaft 43, and through spring 45 to jaw clutch member 36, whereby the latter is yieldingly moved into full meshing engagement with the jaw clutch member 37. The motor is now effective to crank the engine.

During the short interval required to engage member 54 with disk 49 and to move jaw 36 into driving engagement with jaw 37, the motor armature acquires a high speed of rotation and a large amount of kinetic energy is stored therein. The jaw clutch member 37 offers considerable resistance to rotation due to the inertia of the engine parts, and clutch 38 permits relative rotary movement between barrel 28 and the engine crankshaft during the time that the latter is being brought up to speed, whereby damage to the parts is prevented. If the engine backfires during the cranking operation, the multiple disk clutch also permits relative rotation between the engine crankshaft and the barrel, thus protecting that part of the starter against damage.

When the engine starts under its own power, the speed of rotation of jaw clutch member 37 is greater than that of clutch member 36 and the inclination of the teeth of said clutch members is now effective to move member 36 to the right out of driving engagement, whereupon spring 50 is effective to return the weighted member 54 and rod 46 to normal position, provided the motor has in the meantime been de-energized. In the event that the motor is still energized, however, the continued high speed of rotation of the threaded sleeve 51 maintains the inertia member in its extreme leftward position and causes the rod 46 to continue its axially directed pressure on screw shaft 43 and the previously compressed spring 45. Such pressure insures the maintenance of a substantially positive connection between the clutch members 36 and 37 (even in the event of acceleration of the engine connected element 37) so long as the motor remains energized. Upon de-energization of the motor the spring 50 becomes effective to return the parts to the normal positions indicated in Fig. 1 and thereafter yieldingly holds clutch member 36 in non-driving position. When member 36 is forced out of engagement with the member 37, spring 45 yieldingly returns shaft 43 to the position illustrated in Fig. 1.

There is thus provided novel engine starting apparatus of the power actuated type wherein the engine engaging member is automatically moved into and out of driving position. The starter is compact, symmetrical, and light in weight whereby it is particularly adapted for use in aeroplane engines. The use of the friction clutch in combination with the other elements protects the parts against damage in starting and in the event of a backfire. The mechanism is adapted for ready assembly and can be installed as a unit in a number of angular positions.

While only one embodiment of the invention has been illustrated in the drawing it will be understood by those skilled in the art that various changes may be made in the constructon and arrangement of the parts. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:—

1. A starter for internal combustion engines comprising a member adapted for movement into engagement with a member of the engine to be started, a motor having an armature shaft, means including speed reduction gearing for drivably connecting said shaft engine engaging member, and means including an inertia member having threaded engagement with said shaft for moving the engine engaging member to driving position.

2. A starter for internal combustion engines comprising a member adapted for driving engagement with a member of the engine to be started, means including a motor for rotating said member, and means for moving the member to driving position including a rod having operative engagement with the member, yielding

means for normally holding said rod in a predetermined position, and means actuated by said motor and adapted for engagement with said rod to move the latter longitudinally, said last named means including a member movable toward said rod by the first revolution of said motor.

3. In a starter for internal combustion engines, a member adapted to be moved into driving engagement with a member of the engine to be started, means including an electric motor, reduction gearing, and a threaded shaft for rotating said first named member, and means for moving said first named member toward driving position on the first revolution of said motor, said means including a rod having operative engagement with said shaft and engine engaging member, yielding means for maintaining the rod and engine engaging member in non-driving position, and an inertia member actuated by said motor for moving said rod against the tension of said yielding means.

4. In a starter for internal combustion engines, an engine engaging member, power means for rotating said member, means including a threaded shaft for drivably connecting the power means and engine engaging member, a rod slidably connected to said shaft and engine engaging member, and a member mounted for rotary and longitudinal movement into engagement with said rod whereby the engine engaging member is moved to driving position, said last named member being actuated by the first revolution of said power means.

5. In engine starting apparatus, a motor having an armature shaft, an engine engaging member adapted to be actuated by said motor, means including speed reducing mechanism for drivably connecting the armature shaft and engine engaging member, and means threadedly engaging said armature shaft and adapted for longitudinal movement toward the engine engaging member for automatically moving the latter to driving position.

6. In apparatus of the class described a motor, an engine engaging member mounted for rotary and longitudinal movement, means for drivably connecting the motor and engine engaging member, said means including a friction clutch and a train of reduction gearing, and automatic means including an inertia mass threadedly engaging the motor shaft for moving said engine engaging member to driving position.

7. In engine starting apparatus, a motor, an engine engaging member adapted to be driven by the motor, means including speed reduction gearing for drivably connecting said motor and engine engaging member, and means for moving the engine engaging member to driving position including a rod slidably extending through the engine engaging member, resilient means for normally maintaining the engine engaging member and rod in a predetermined position, and an inertia member actuated by the motor and adapted for longitudinal movement into abutting engagement with said rod.

8. In starting apparatus for an internal combustion engine a motor having an armature shaft, a rotatable member adapted for movement into driving engagement with a member of the engine to be started, means including a longitudinally movable shaft drivably connecting the rotatable member with said armature shaft, and means for moving the engine engaging member to driving position, including an inertia member mounted on the armature shaft and a member interposed between the inertia member and longitudinally movable shaft, said interposed member being actuated by the inertia member.

9. In apparatus of the class described an engine engaging member, a motor having an armature shaft, means drivably connecting the engine engaging member and armature shaft, said means including a member drivably connected to the engine engaging member but movable longitudinally with respect thereto, yielding means interposed between the engine engaging member and relatively movable but drivably connected member, and inertia means mounted on said shaft and adapted to exert an axially directed thrust on the last named member to impart longitudinal movement thereto.

10. The combination in a starter, of high and low speed shafts, means operated from the high speed shaft for effecting engagement of the starter with the engine, and means operated from the low speed shaft for driving the engine.

11. The combination with a starter drive shaft, of an engine-engaging member connected to said shaft for movement axially of the shaft and for rotational movement with said shaft, and means to produce said movements, said means including a gear train effective to produce the rotational movement only, and a meshing member distinct from but rotatable with said gear train, said meshing member being movable axially to produce a corresponding axial movement of said engine-engaging member.

12. The combination in a starter, of high and low speed shafts, means operated from the high speed shaft for effecting engagement of the starter with the engine, and means operated from the low speed shaft for driving the engine, said first named means being axially movable during the first revolution of said high speed shaft to effect said engine engagement.

13. The combination in a starter of axially aligned high and low speed shafts, means operated from the high speed shaft for effecting engagement of the starter with the engine, and means operated from the low speed shaft for driving the engine, said first named means being axially movable during the first revolution of said high speed shaft to effect said engine engagement.

14. In a starter mechanism having complementary starter and engine members constructed for overrun by the engine member of the starter member and thereafter subject to back-lash, the combination of a starter drive shaft, a driving connection between said shaft and the starter member, and means to maintain said starter member in contact with said engine member when the engine overruns the starter drive shaft, prior to de-energization of the starter drive shaft.

15. A starter for internal combustion engines comprising a member adapted for movement into engagement with a member of the engine to be started, a motor having an armature shaft, means including speed reduction gearing for drivably connecting said shaft and engine-engaging member, means including a member mounted for rotary and longitudinal movement about and along the axis of rotation of said shaft for moving the engine-engaging member to driving position, and means for rotating said longitudinally movable member at the speed of said armature shaft.

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