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ENGINE STARTING MEANS

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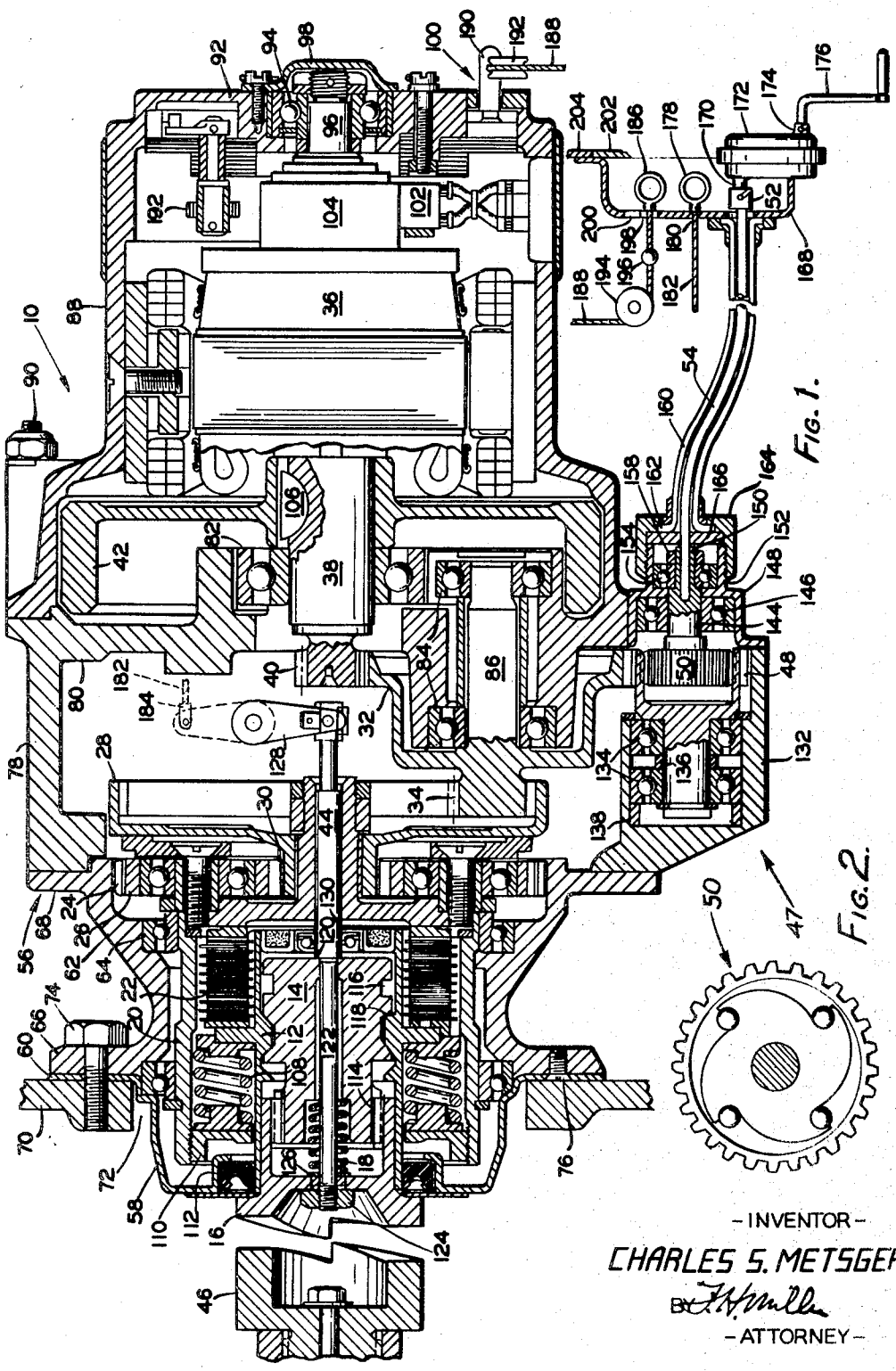


FIG. 1.

FIG. 2.

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ENGINE STARTING MEANS

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1

This invention relates to engine starting means and particularly to means, in combination with a locally operated starter adjacent to the engine, for starting the engine independently of the local starter operating means through the intermediary of a portion of such starter from a position spaced from, or remotely disposed relative to, the starter.

Starting means of the aforesaid general character have heretofore embodied structure adding considerable length to the starter, which is disadvantageous in many applications from the standpoint of space requirements, and critical in an airplane because of the close proximity of the fire wall to the rear end of the engine shaft.

In addition, since the starter is already relatively long, and in many cases mounted only at one end, when the above mentioned length is added to the free end, excessive cantilever strain is imposed on the starter mounting.

The added length and weight at the free end are conducive to greater adverse vibration effects and greater likelihood of injury, which must be avoided, as by additional strength at the mounting end and other parts, with the resultant increase of cost.

A starter having an electric motor, in which high speed of the motor armature shaft is translated into slow speed of the starter clutch or jaw member through the intermediary of a gear train, has also usually heretofore been locally hand cranked or remotely operated by means connected to a slow speed gear of such train, which structure renders the engine difficult to hand crank.

It is also impractical, if not impossible, in many applications, as in airplane practice, to have any substantial rigid lateral projections from the longitudinal sides of a starter.

Among the objects of the present invention are to overcome all of the above-mentioned and other disadvantages of former starters, and to do so by novel improved means.

Another object, in association with a starter having local operating means, is to provide means, free from the ends of the starter and from rigid means extending laterally for any appreciable extent from a longitudinal side of the starter, for starting the engine independently of the local or usual starter operating means.

Another object, in association with a starter having a motor and a gear train for operating the starter clutch at a speed reduced from that

2

of the motor, is to provide means for operating the starter clutch independently of the motor through a high speed gear of such train, and operable from a position spaced from the starter through the intermediary of means avoiding the requirement for the aforesaid laterally projecting rigid means.

Another object is to provide means of the above indicated character that is simple and durable in construction, economical to manufacture, and effective in its operation.

These and other objects and features of the invention are pointed out in the following description in terms of the embodiment thereof which is shown in the accompanying drawing. It is to be understood, however, that the drawing is for the purpose of illustration only, and is not designed as a definition of the limits of the invention, reference being had to the appended claims for this purpose.

In the drawing:

Figure 1 illustrates a structure including one form of the invention as actually constructed and applied to a standard starter of existing type, and including means illustrated diagrammatically for operating the structure from a position spaced from the starter.

Figure 2 is an end view of the overrunning clutch of Figure 1.

Referring to the drawing, an engine starter 10, therein shown, comprises, in general, an axial stationary rotatable spline nut 12, a screw shaft 14 in the nut 12, a starter jaw clutch member 16 adapted for rotation with, and axial movement relative to, the screw shaft 14, spring means 18, between the screw shaft 14 and the jaw member 16, a rotatable drum 20, a friction disc clutch pack 22 having discs connected to the drum 20 and the nut 12, respectively, a non-rotative orbital gear 24, rotatable planet gears 26 carried by the drum 20 and engaging the orbital gear 24, a rotatable internal gear 28 having a sun gear portion 30 engaging the planet gears 26, a rotatable drum gear 32 having a pinion portion 34 engaging the internal gear 28, a motor 36 including a rotatable armature shaft 38 carrying a pinion 40 engaging the drum gear 32, a flywheel 42 carried by the armature shaft 38, and a meshing rod 44 adapted to push the screw shaft 14 to cause the latter to act through the intermediary of the spring means 18 to engage the starter jaw member 16 to an engine jaw element 46 whereupon, when the flywheel 42 attains a certain speed, the nut 12 rotates the jaw member to break the engine

seal. It is to be noted that all of the aforesaid rotatable parts rotate about axes extending in the same direction, or in other words, about axes that are parallel, coincident or in line relative to each other.

The invention, in addition to a change in the above generally described starter 10, comprises, in general and in combination therewith, means 47, at the lower center of the figure, including a drum pinion 48 engaging the drum gear 32 and having the drum pinion axis parallel to the axis of the drum gear 32, a clutch 50, in the drum pinion 48 adapted to rotate the latter when the motor 36 is deenergized and for overrunning by the drum pinion 48 when the motor is energized, a bayonet fitting or rotative driving element receiving means 52, at the lower right of the figure, adapted to be disposed in position spaced from the starter 10, and a flexible shaft 54 connected to the receiving means 52 and to the drum pinion clutch 50 coaxially of the latter.

The starter 10, in other particulars, comprises a housing 56 including an inner end portion 58 having a flange 60, a portion 62, in which the drum 20 is journaled as by bearings 64, and including the orbital gear 24 as a fixed part of the portion 62, and having flanges 66 and 68.

The end portion 58 of the housing 56 is secured to an engine crank case wall 70 in an opening 72 thereof, as by studs 74 extending through the flanges 60 and 66 and the crank case wall, and attached to the flange 66 independently of the bolts 74, as by screws 76.

The flange 68 is secured to another portion 78 of the housing 56, which portion 78 has a wall 80 supporting a bearing 82 for the armature shaft 38 and bearings 84 for a shaft portion 86 of the drum gear 32.

The housing 56 further comprises a portion 88 secured to the portion 78, as by studs 90, enclosing the motor 36 and having a portion 92, supporting a bearing 94 for an outer end portion 96 of the armature shaft 38, and having an end cap 98. Means 100 is also supported by the housing portion 92, for raising and lowering brushes 102 relative to a commutator 104 of the motor 36. The flywheel 42 is secured to the armature shaft 38, as by a key 106.

The friction, between the discs of the clutch pack 22, is maintained by springs 108 which are adjusted by a ring nut 110 screw threadedly mounted in the drum 20. Means 112 secured to the end portion 58 of the housing 56 in this instance merely seals the housing 56 against the admission of oil from the crank case 70, although in other applications it may be adapted to additionally operate to frictionally hold the jaw 16.

The screw shaft 14 has a spline connection 114 to the jaw member 16 whereby the latter is adapted to rotate with, and move axially relative to, the screw shaft, the latter of which has coarse screw thread connection to the spline nut 12 and a shoulder 116 adapted to engage a shoulder 118 of the spline nut for causing the screw shaft to drive the jaw 16 to start the engine when the shoulder 116 engages the shoulder 118.

The meshing rod 44 has a shoulder 120 adapted to push the screw shaft 14, and a portion 122 extending, in this instance, through the spring means 18 and a hole in the jaw member 16. A nut 124 holds the jaw 16 to the meshing rod portion 122, which is surrounded, at the inner side of the jaw 16 with a sliding seal 126 held against the jaw 16 by the spring 18. A lever 128,

shown diagrammatically, pivotally connected to the rod 44, is adapted for operation by a solenoid or by hand at a position adjacent to the starter 10 in a usual manner, and from a position spaced from, or remotely disposed relative to the starter, as will later appear.

Means 130 provides a fluid seal around the rod 44, and a seal against the admission of particles abraded from the discs of the clutch pack 22 to the nut 12.

The housing portion 78, which, in cross section, is of generally cylindrical shape before the addition of the means 47, has a slight bump, or radially outwardly raised curved portion to accommodate an adjacent arc of the drum gear 32 at about the longitudinal center of the starter 10.

In this instance, by only slightly raising the former bump to form a new bump or housing portion 132, the means 47 is disposed partially within the former cross-sectional contour of the housing portion 78 thereby conserving side room of the starter. Since, as stated hereinabove, it is impractical, if not impossible in many applications, as in airplane practice, to have any substantial rigid lateral projection from the longitudinal sides of the starter, the above-mentioned construction, whereby the means 47 is disposed partially within the former contour of the housing portion 78, constitutes a novel feature rendering the present invention possible, since it does not laterally extend the starter structure beyond a practical limit.

With no rigid projection of greater lateral or radial extent than the bump 132, the starter may be turned or rotated about its longitudinal axis, and mounted in any of several positions to avoid interference with adjacent engine parts or accessories.

In conjunction with the above described feature, it is of further particular note that the drum pinion 48, engages the drum gear 32, which is a high speed gear of a train including the pinion 40, the pinion portion 34 of the drum gear 32, the internal gear 28, the sun gear 30, the planet gears 26 and the orbital gear 24. In former practice, gears and pinions corresponding to the pinion 48, engage a low speed gear, or a gear closer to the jaw 16 in a corresponding train, whereby it is considerably more difficult, or requires more structure externally of the starter to obtain comparable results.

The means 47, in further particular, comprises the bump or auxiliary housing 132 secured to the housing portion 78 and having a tubular portion inclosing, in this instance, anti-friction bearings 134 spaced apart, as by a spacer 136, and from one end of the housing 132, as by a spacer 138.

The pinion 48 is in the form of a hollow drum having external gear teeth, engaging the teeth of the drum gear 32, and a stub shaft portion 140 in the bearings 134. The pinion is axially held in place by a lock ring 142 operating between the shaft 140 and one side of the inner race of one of the bearings 134, and by a shoulder of the drum against an opposite side of the inner race of the other bearing.

The clutch 50, as illustrated in Fig. 2, is of a usual ball or roller lock type, in this instance embodying rollers, which rollers, when the clutch 50 is rotated in a direction to start the engine, engage and lock against the inner longitudinal face of the drum of the pinion 48 and, when the clutch 50 is stationary and the drum gear 32 is rotated by the motor 36, allow the drum pinion

48 to override the clutch 50. This structure may obviously be replaced by equivalently operating means, similar to the nut 12, the screw shaft and other elements for engaging the jaw member 16 to the jaw element 46.

The clutch 50, in this instance, further comprises a stub shaft 144 journaled in a bearing 146 in a housing 148, and having a portion 150 of reduced diameter in an exteriorly screw threaded extension 152 of the housing 148, between which extension and the portion 150 is provided a bearing 154.

The portion 150 has an axial opening for the reception of one end of the flexible shaft 54, and a radially split exteriorly screw threaded outer end for the reception of a nut 158 fixed in position after tightly radially clamping the flexible shaft 152 to the clutch 50. A flexible shield 160 for the flexible shaft 54 has a flanged inner end 162 held in place in a recess of a cap nut 164 on the extension 152 and spaced from the adjacent end of the extension by a washer 166.

At its opposite end, the shield 160, which flexes laterally with the shaft 54, but does not rotate therewith, is fixed to a stationary member 168, which may be a part of an airplane disposed at a position remote from the starter 10. At the member 168, the flexible shaft 54 is provided with the means 52, such as a usual socket having bayonet slots, for receiving a rotatable driving element 170, indicated in this instance as the output element of a speed step up gear train, in a gear box 172, having an input element 174 similar to the means 52 for operation as by a hand crank 176, as shown, or by a portable motor or other means.

Operating means 178, shown in the form of a ring, for the meshing rod 44, is mounted, at the position of the member 168 adjacent to the means 52, on one end 180 of a cable 182 having its other end 184 connected to the lever 128 at the upper center of the figure.

Operating means 186, for the brush lifting means 100 is also mounted at the position of the member 168 at one end of a cable 188 having its other end connected to a member 190 of the means 100. The cable 188 extends over a pulley 192, in this instance, whereby the cable is directed to pull the means 100 about the axis of the armature shaft 38 to lift the brushes 102 from the commutator 104 against the action of springs 192. The cable 188 extends around another pulley 194, and is provided with a fixed ball or button 196. When the brushes 102 are to be lifted, the operating means 186 is pulled to move the ball 196 through an opening 198 in the member 168, after which a portion of the cable, at the left of the member 168 as shown, is lifted into a slot 200 above the opening 198 to lock the ball 196 in position in which the brushes are lifted. To replace the brushes to position on the commutator, it is only necessary to lower the ball 196 into register with the opening 198, whereupon the springs 192 return the brushes to operative position.

The member 168 is shown as in the form of a service box enclosing the receiving means 52, and the operating means 178 and 186, and having a movable cover 202 adapted to lie flush with an airfoil surface element 204 of an airplane.

In operation by the motor 36, in this instance, when the motor is energized to bring the flywheel 42 up to speed for cracking the engine seal, although the above-mentioned gear train is in

operation, the jaw 16 is not engaged thereby to the jaw 46.

When the flywheel attains the aforementioned speed, the lever 128 is actuated by the aforementioned means in the cockpit, since this is the procedure when the starting is effected by the motor 36. Actuation of the lever 128 moves the meshing rod 44 to the left as shown, whereby the shoulder 120 pushes the screw shaft 14 and causes it to turn in the nut 12 until the jaw member 16 engages the jaw element 46, whereupon the shoulder 116 of the screw shaft 14 engages the shoulder 118 of the nut 12 and thereby turns the engine jaw element 46 to crack the engine seal as aforesaid, which action, in this case, is immediately followed by the torque of the motor 36 in turning the jaw element 46 to start the engine, if the flywheel energy is dissipated. If the energizing switch is opened, the flywheel alone supplies the torque. In a combination inertia-direct cranking starter, the two energies are additive.

The motion in cracking the engine seal and starting the engine is transmitted from the armature shaft 38 through the pinion 40, the drum gear 32, the pinion 34, the internal gear 28, and the sun gear 30 to the planet gears 36. Since the latter are mounted on the drum 20 and engage the stationary orbital gear 24, the reaction is a turning of the drum 20, and, with the drum through the intermediary of the clutch pack 22, also a turning of the nut 12, which as above stated, with the shoulder 116 engaged to the shoulder 118 as aforesaid, causes turning of the jaw 16.

Also, during the above-described actions resulting from energization of the motor 36, with the clutch 50 inactive, the drum pinion 48 is rotated by the drum gear 32 to cause the pinion 48 to override the clutch 50.

In operation, from the position of the means 52 and 178 independently of the motor 36, or in other words, when the motor is deenergized, the operating means 186 is first operated to lift the brushes 102 from the commutator 104, which relieves the armature shaft 38 of the brush drag and renders the operation much easier and the construction less complicated and expensive. The hand crank 176, as shown, or a portable motor having a portion corresponding to that portion of the crank 176 which is placed in the receiving means 52, is placed in the latter means and cranked in a usual manner. This action, from the crank 176, or from the portable motor, to the input element 174, through the gear train in the gear box 172, transmits low-torque high-speed rotation to the output element 170 of the train. From the element 170, such rotation is transmitted through the flexible shaft 54 to the clutch 50 whereby the rollers of the latter grip the inner side surfaces of the drum pinion 48 to rotate the latter and consequently, the drum gear 32, the pinion 40 and the armature shaft 38 for bringing the flywheel 42 up to speed.

Rotation of the drum gear 32 carries the pinion 34 with it, to rotate, as aforesaid, the internal gear 28, the sun gear 30, and the planet gears 26 against the stationary orbital gear 24, to rotate the nut 12 through the intermediary of the clutch pack 22.

When the flywheel attains the speed for cracking the engine seal, the operating means 178 is pulled, which action is transmitted through the cable 182 to the lever 128, which turns clockwise, as viewed in the figure, to move the meshing rod

44 to the left for engaging the jaw 16 to the jaw 46, whereupon the engine seal is cracked and the engine started as in the case above-described in connection with the operation by the motor 36.

Although only one embodiment of the invention has been illustrated and described, various changes in the form and relative arrangements of the parts, which will now appear to those skilled in the art, may be made without departing from the scope of the invention. Reference is, therefore, to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In a device for an engine starter of a type having a housing including a gear train housing portion normally of given cross sectional area having a slight side wall bump, actuating means including a flywheel and a motor having a shaft, a pinion on the motor shaft, a member at the front end of the housing rotatable about an axis extending in the direction of the motor shaft and adapted for cooperation with an engine element to start the engine, and means in the housing including a gear train operatively connected between the actuating means and the member for driving the latter by the actuating means and embodying a bell gear meshing with the pinion and disposed in the gear train housing portion opposite the bump, the combination of a gear train housing portion in the place of said first gear train housing portion having an only slightly larger corresponding bump, and a structure added to such starter along the side thereof comprising means rotatable about an axis parallel to said side including an engine cranking pinion within the larger bump meshing with the bell gear, clutch means, and a flexible shaft connected at its inner end to the clutch means and extending therefrom for an initial length generally along said side wall and having outer-end means for receiving a member adapted to rotate the flexible shaft, the clutch means operating to maintain the flexible shaft inactive during operation of the gear train by the actuating means but responsive to rotation of the flexible shaft during inaction of the actuating means for driving the cranking pinion to rotate the member through the bell gear and other gears of the train.

2. In an engine starter of a type normally of given cross sectional area comprising actuating means including a flywheel and a motor, a member at one end of the starter adapted for cooperation with an engine element to start the engine, and means including a gear train operatively connected between the actuating means and the member for driving the latter by the actuating means, the combination of structure added to such starter along the side thereof comprising means rotatable about an axis parallel to said side and having portions disposed at least partially within said area including an engine cranking gear meshing with a gear of the train, a flexible shaft for driving the cranking gear, and means between the cranking gear and the flexible shaft for maintaining the flexible shaft inactive during operation of the gear train by the actuating means but responsive to rotation of the flexible shaft for driving the cranking gear to rotate the member through gears of the train during inaction of the actuating means.

3. In an engine starter of a type normally of given cross sectional area comprising actuating means including a flywheel and a motor, a member at one end of the starter adapted for cooperation with an engine element to start the engine, and means including a gear train operatively connected between the actuating means and the member for driving the latter by the actuating means, the combination of structure added to such starter along the side thereof comprising means rotatable about an axis parallel to said side and having portions disposed at least partially within said area for rotating the member through gears of the train independently of the actuating means, a flexible shaft for driving the rotatable means of said structure, and means for maintaining the flexible shaft inactive during operation of the gear train by the actuating means but responsive to rotation of the flexible shaft for rotating the member through gears of the train independently of the actuating means as aforesaid during inaction of said actuating means.

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