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INTEGRAL POSITIVE ENGAGEMENT STARTER

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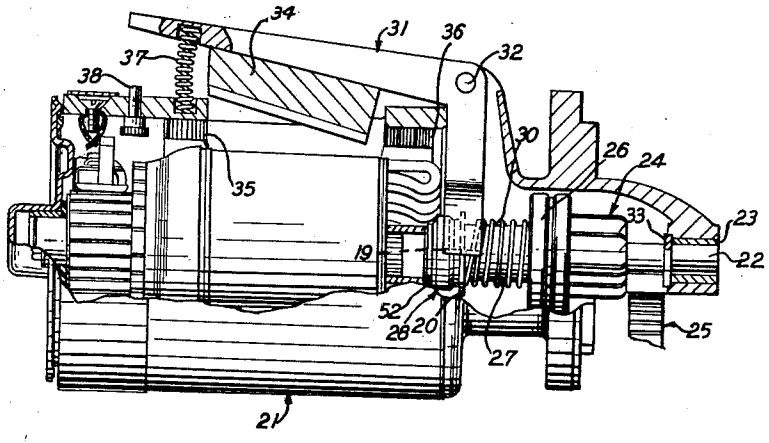


FIG. 1

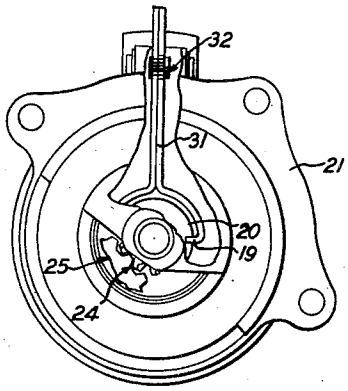


FIG. 2

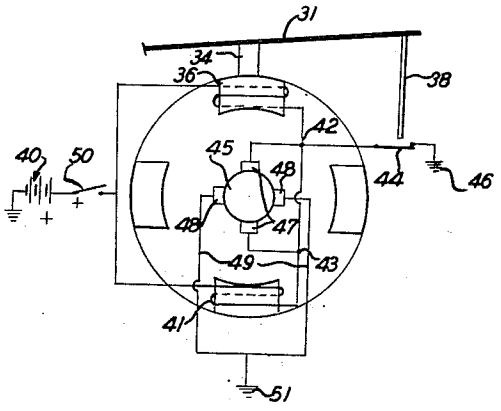


FIG. 3

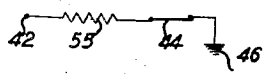


FIG. 4

A. E. JENSEN
INVENTOR.

BY E. C. McRae
J. R. Faulkner
L. H. Oster
R. T. Seeger
ATTORNEYS

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INTEGRAL POSITIVE ENGAGEMENT STARTER

Arvid E. Jensen, Ypsilanti, Mich., assignor to Ford Motor Company, Dearborn, Mich., a corporation of Delaware

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This invention pertains to a motor vehicle integral positive engagement starter and more particularly to a starter which utilizes one of the field coils in the starter motor to effect the engagement of the starter pinion with the ring gear of a flywheel.

It is an object of this invention to provide a simplified construction for a positive starter motor pinion assembly motivator. It is an object of this invention to provide a starter motor construction wherein the field coils are used to attract a plunger which motivates an arm which is connected to starter motor pinion, effecting a driving relation between said pinion and an engine turning means such as the flywheel. It is a further object of this invention to provide a construction where there are means to divert the starting current wholly through the field coils bypassing the armature thereby providing an increased amount of flux for attracting the above mentioned arm and restrict armature revolution until the arm has been moved and the pinion and flywheel have been engaged or prepared for engagement.

Other objects and advantages of this invention will be made more apparent as this description proceeds, particularly when considered in connection with the accompanying drawings wherein:

Figure 1 shows an embodiment of this invention in side elevation with a portion cutaway;

Figure 2 shows the assembly of Figure 1 viewed from an end;

Figure 3 is a schematic wiring diagram for an embodiment of this invention; and

Figure 4 is a schematic wiring diagram showing a variation of Figure 3.

In this embodiment, a bellcrank is pivoted to a starting motor housing and this bellcrank has a plunger arm and a bifurcated arm with each prong of the bifurcated arm having an inwardly extending slotted flange with a pinion rim loosely fitting into the slots although the connection between the pinion and arm may take many forms. The plunger is adapted to fit into a formed core in the motor frame and field coils and acts as a pole shoe when drawn into the core. The slots fit about the rim of a member which urges the starter motor pinion into driving engagement with the motor vehicle engine flywheel thereby turning said flywheel in preparation for starting of the engine. When current is applied to the field coils, the plunger is attracted rotating the bellcrank and forcing the pinion assembly into engagement with the flywheel. When the starter is de-energized, stopping current flows through the field coils, a spring returns the bellcrank to its initial position thereby allowing for disengagement of the starter motor pinion from the flywheel. An overrunning clutch is preferably placed between the starter motor pinion and the armature shaft so that in the event that the starter is applied after the engine has become self sustaining, the armature will not be driven at excessive speeds. This invention may also be provided with a switch which bypasses the armature sending full starting current through the field coils. This switch is opened by the plunger arm of the

bellcrank when it has nearly completed its travel into the field coil thereby sending full current through the armature and turning the pinion with full torque. Bypassing the armature current until the switch is opened not only provides a large current through the field coils thereby aiding in attracting the plunger into the core but restricts the torque applied to the pinion during engagement with the flywheel thereby providing a smoother mesh. The pinion is held in engagement until the starting circuit is opened thereby providing the additional advantage of a positive start.

Looking at Figure 1 is seen a starter motor assembly incorporating an embodiment of this invention. Starting motor **21** has armature shaft **22** which is journaled in bearing **23**. Pinion assembly **24** is attached to armature shaft **22** by means of a loose helical spline barrel **27** so that it can rotate and slide longitudinally with and on shaft **22**. An overrunning clutch is placed between barrel **27** and shoulder **26** of pinion **24** so that a high rotation of pinion **24**, such as that as would be experienced when the engine becomes self sustaining, will not turn the armature at excessive speeds. Spring **30** is placed about barrel **27** of pinion assembly **24** and abuts against shoulder **26** and collar **28** which is slidably mounted on barrel **27**. Collar **28** is spring urged against shoulder **52** which is fixed to shaft **27**. Bellcrank **31** is pivoted at **32** to the starter motor housing and the vertical arm of bellcrank **31** is bifurcated and each prong is provided with an inwardly extending slotted flange **19** which rides on rim **20** of collar **28**. The horizontal arm of bellcrank **31** is provided with plunger **34** which reciprocates in core **35** which is formed through field coil windings **36**. Spring return **37** urges bellcrank **31** to its initial position as shown in Figure 1. Arm **38**, opening switch **44**, is operated by the horizontal arm of bellcrank **31** in its lattermost travel into core **35**. Thrust bearing snapring **33** snaps about a groove on shaft **22** and against the end assembly.

In Figure 2 is shown an end view of the relationship between bellcrank **31** and starter motor **21** and also is cutaway to show the engagement between bifurcated arm of bellcrank **31** and rim **20**. Also shown is the engagement between pinion **24** and flywheel **25**, the teeth of which are tapered to provide a more certain engagement.

In Figure 3 is shown a schematic wiring diagram for an embodiment of this invention. Battery **40** supplies potential to field windings **41** which are connected at **42** and **43** to brushes **47** which are connected through commutator **45** to the armature. Brushes **48** connect the armature through commutator **45** to ground **51**. Connection **42** is connected to ground **46** through switch **44** which is opened by arm **38** when bellcrank **31** and plunger **34** are drawn downwardly by field coil **36**.

In Figure 4 is shown the connection between **42** and ground **46** with resistance **55** added.

The operation of this embodiment is as follows. Current is sent through field coils **36** by the motor vehicle battery when the starter button or switch is turned on. A field is set up in the center of field coil **36** which attracts plunger **34** which may be of a ferrous material. This downward movement of the horizontal arm of bellcrank **31** imparts a rightwardly movement to the vertical arm of bellcrank **31** thereby causing collar **28** to be moved rightwardly compressing spring **30** under the pressure of roller **33** in groove **29**. Pinion **24** is moved rightwardly by the force of spring **30**. If the teeth in pinion **24** are not aligned with those of flywheel ring gear **25** at first, spring **30** will be compressed supplying and storing necessary force to urge proper engagement between the teeth of pinion **24** and those of flywheel **25** when they do come into alignment. The teeth on pinion **24** and flywheel **25** are chamfered to receive each other readily. The fact that the starting motor frame is saturated with flux momentarily on the

first surge of current through the field coils aids in drawing plunger **34** into core **35**. Once the plunger **34** is so drawn into core **35** it remains there during the entire period of starter motor activation thereby providing field coil **36** with a complete pole shoe and also keeping pinion **24** engaged with flywheel ring gear **25**. When starter motor switch **50**, seen in Figure 3 is opened manually or automatically, field coil **36** becomes de-energized and spring **37** forces the horizontal arm of bellcrank **31** upwardly imparting a leftwardly movement to collar **28** which abuts shoulder **52** on barrel **27** and pinion **24** is drawn out of engagement with flywheel ring gear **25**. The helical splined connection aids in driving pinion **24** into full engagement with flywheel ring gear **25** after the initial engagement has been made. Also, the engagement is more readily broken when the engine becomes self sustaining.

In Figure 3 is shown a wiring diagram for an embodiment of this invention including switch **44** and ground **46**. Switch **44** supplies certain additional advantages. When starter switch **50** is manually closed, battery potential is applied through field coils **36**, **41** and switch **44** which is closed during non-operation of the starting motor provides a low resistance path to ground from connection **42** thereby bypassing the relatively high resistance path offered through brushes **47**, commutator **45** and the armature. This sends very high current through field coils **36**, **41** additionally aiding in quick and complete traction of plunger **34** into core **35**. Near the end of plunger **34** travel, bellcrank arm **31** contacts arm **38** opening switch **44** thereby sending full current through brushes **47**, commutator **45** and the armature to ground **51**. In this manner, little or no torque is developed in the armature during the movement of bellcrank **31**. A resistance may be placed between connection **42** and ground **46** such as resistance **55** in Figure 4 so that a slight current is diverted through the armature turning armature shaft **22** at a low speed and low torque thereby facilitating engagement between pinion **24** and flywheel ring gear **25** by providing multiple alignments between the teeth of pinion **24** and flywheel ring gear **25**.

It will be understood that the invention is not to be limited to the exact construction shown and described, but that various changes and modifications may be made without departing from the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. An internal combustion engine starter assembly comprising a frame, a field coil supported on said frame, an armature rotatably mounted in said frame, an armature shaft supporting said armature, an armature shaft pinion slidably mounted on the armature shaft and rotatably driven thereby, said pinion being engageable with engine crankshaft turning means, a bell crank having one end adjacent said pinion and the other end attached to a plunger, and an opening through the frame to permit the bell crank to carry the plunger through the frame and into the field coil, said bell crank being spring biased to move the plunger away from the field coil and frame, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring whereby the pinion will be moved into engagement with the crankshaft turning means when the plunger moves through the frame and into the field coil.

2. An internal combustion engine starter assembly comprising a frame, a field coil supported on said frame, an armature rotatably mounted in said frame, an armature shaft supporting said armature, an armature shaft pinion slidably mounted on the armature shaft and rotatably driven thereby, said pinion being engageable with engine crankshaft turning means, a bell crank having one end adjacent said pinion and the other end attached to a plunger, and an opening through the frame to permit the bell crank to carry the plunger through the frame and into the field coil, said bell crank being spring biased to move the plunger away from the field coil and frame, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring whereby the pinion will be moved into engagement with the crankshaft turning means when the plunger moves through the frame and into the field coil, the armature being normally electrically short circuited by a shunt, said shunt being opened by passage of the plunger into the field coil.

References Cited in the file of this patent

UNITED STATES PATENTS

1,301,478	Midgley	Apr. 22, 1919
1,331,168	Richard	Feb. 17, 1920
2,059,624	Collins	Nov. 3, 1936
2,482,534	Antonides	Sept. 20, 1948
2,611,274	Thorpe	Sept. 23, 1952
2,716,895	Antonides	Sept. 6, 1955

FOREIGN PATENTS

419,835	Great Britain	Nov. 20, 1934
755,749	France	Sept. 11, 1933
44,090	France	July 23, 1934
45,035	France	Feb. 25, 1935