April 17, 1962 A. E. JENSEN 3,030,518

INTEGRAL POSITIVE ENGAGEMENT STARTER

Original Filed Sept. 18, 1957 4 Sheets-Sheet 1

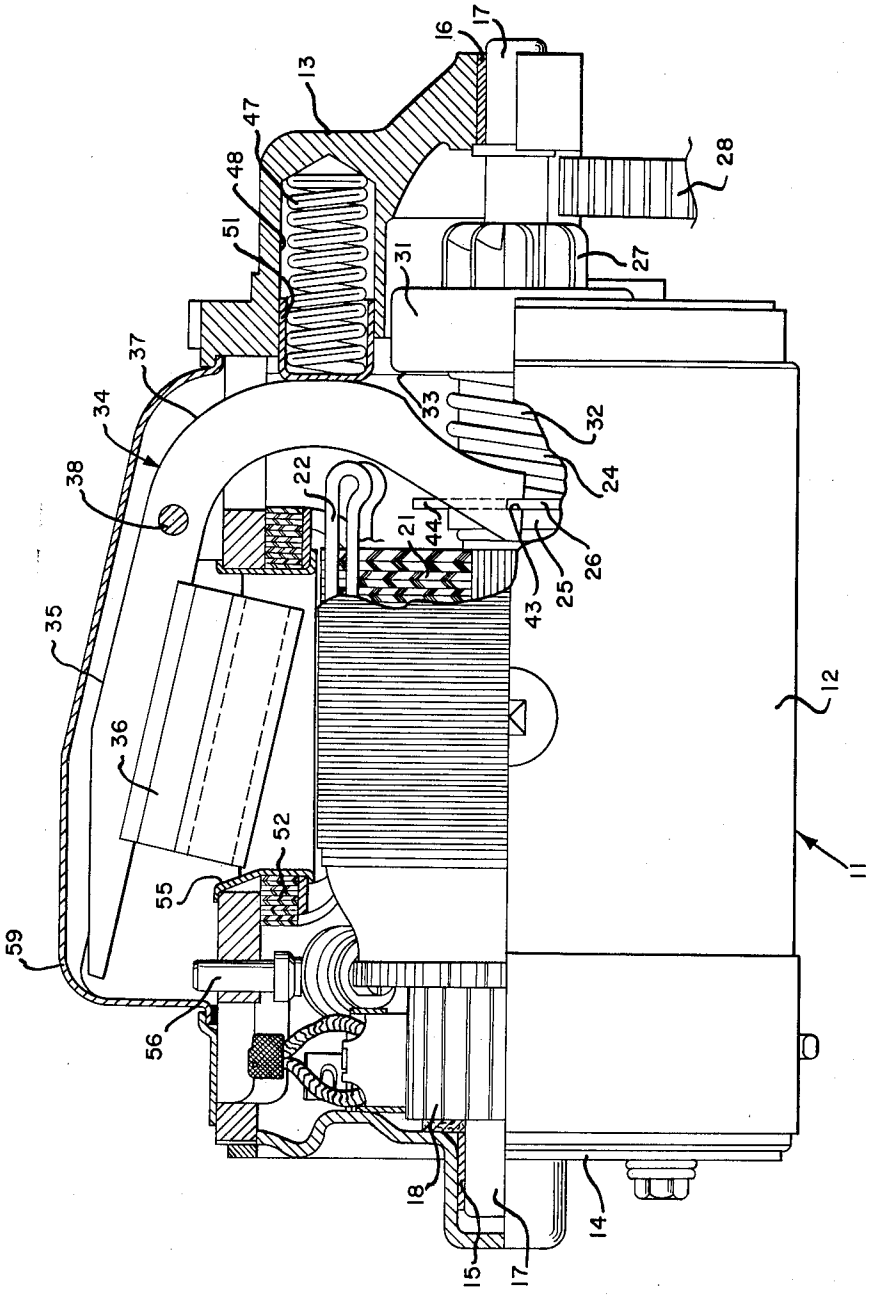


FIG. 1

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INTEGRAL POSITIVE ENGAGEMENT STARTER

Original Filed Sept. 18, 1957 4 Sheets-Sheet 2

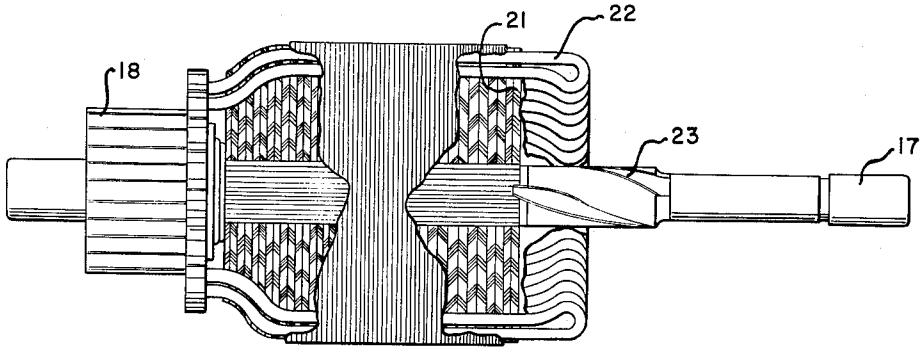


FIG. 3

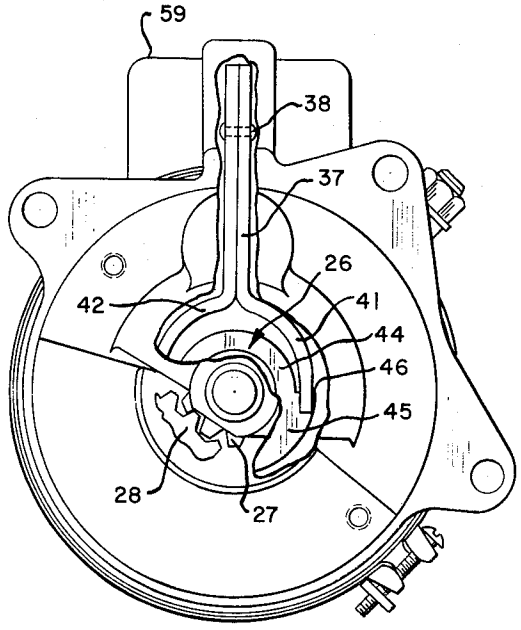


FIG. 2

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INTEGRAL POSITIVE ENGAGEMENT STARTER

Original Filed Sept. 18, 1957 4 Sheets-Sheet 3

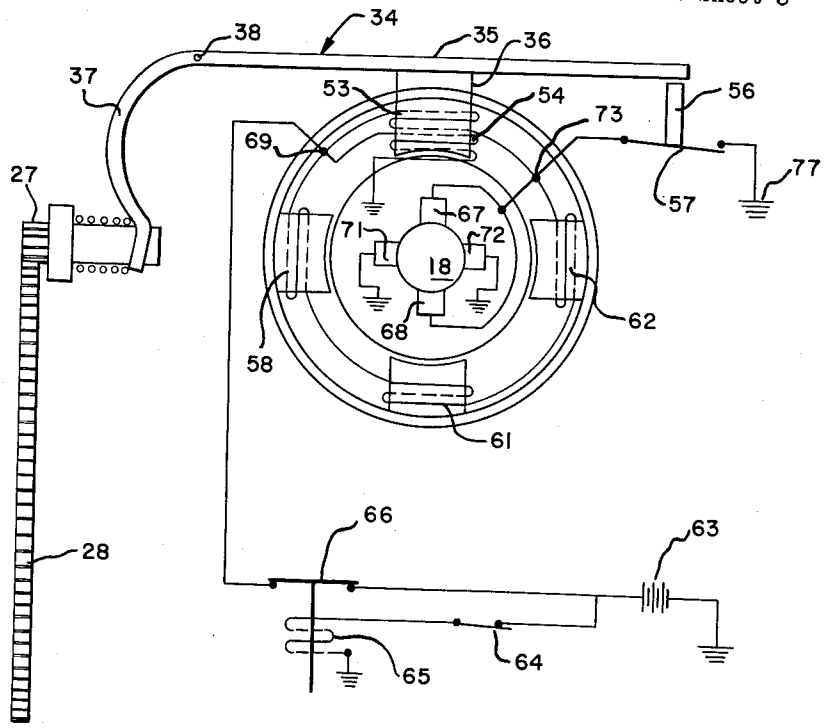


FIG. 4

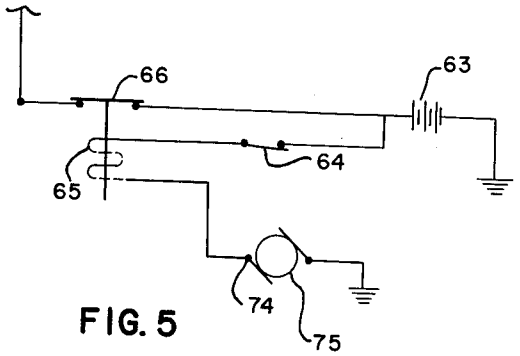


FIG. 5

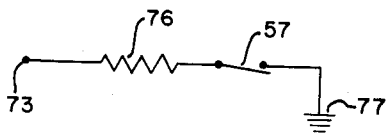


FIG. 6

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INTEGRAL POSITIVE ENGAGEMENT STARTER

Original Filed Sept. 18, 1957 4 Sheets-Sheet 4

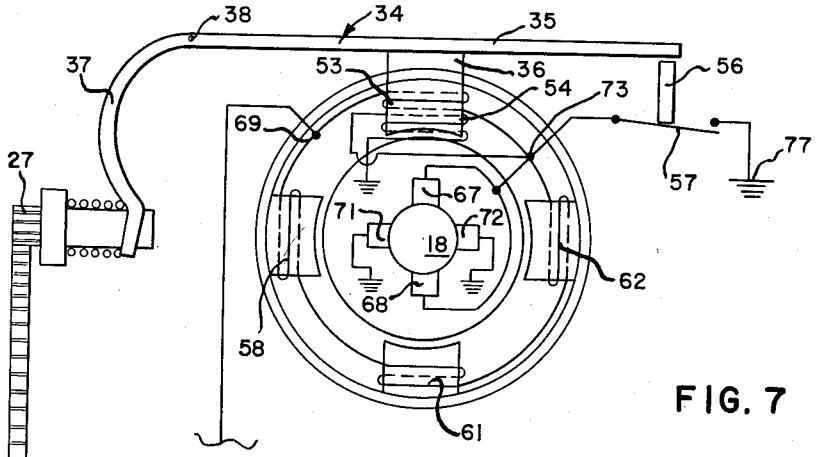


FIG. 7

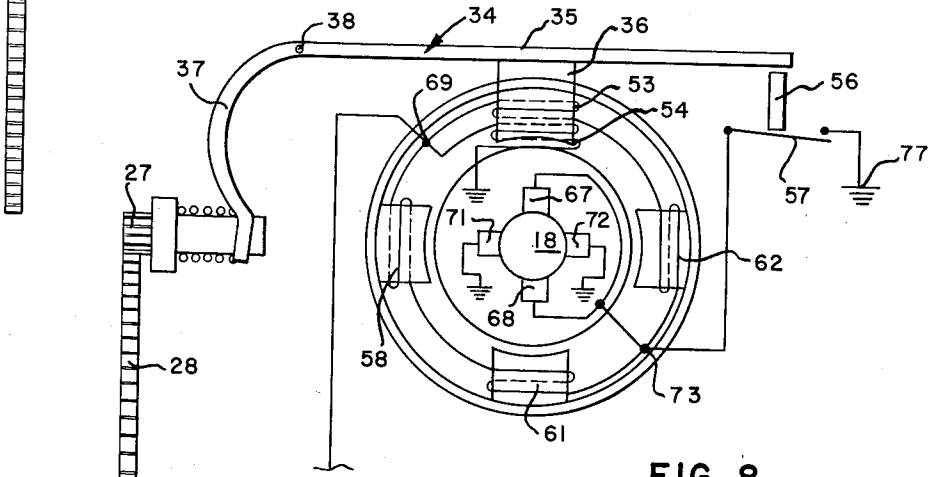


FIG. 8

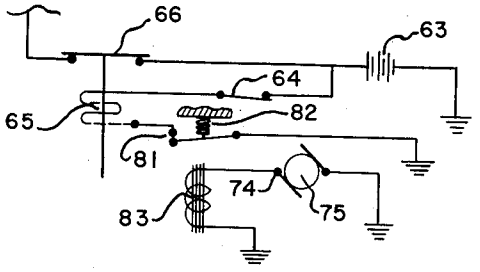


FIG. 9

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United States Patent Office 3,030,518 Patented Apr. 17, 1962

3,030,518

INTEGRAL POSITIVE ENGAGEMENT STARTER

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Continuation of application Ser. No. 684,670, Sept. 18, 1957. This application Sept. 1, 1960, Ser. No. 54,567

23 Claims. (Cl. 290—36)

This invention relates to a motor vehicle integral positive engagement starter and more particularly to such a starter in which a parallel or shunt field coil is employed in conjunction with a series field coil to effect engagement of the starter with a driving means for an engine and to hold said starter in engagement with the driving means, and in which the space between the end of the armature core and the ends of the armature coils is utilized to effect a reduction in the length, weight and cost of the starter.

This application is a continuation of my copending application S.N. 684,670, filed September 18, 1957.

This invention is intended as an improvement over the integral positive engagement starter disclosed and claimed in my copending application Serial Number 572,538, filed March 19, 1956, and allowed February 27, 1957, now Patent 2,813,206, issued November 12, 1957. This starter is a series wound machine which utilizes the magnetic field generated by one of the series coils to effect engagement of the starter pinion with the ring gear of the flywheel in an internal combustion engine. A bell crank pivotally mounted upon the frame of the starter carries a plunger upon one of its arms which is adapted to be drawn into an opening in the frame of the machine and into one of the series coils when the coil is energized through the starter solenoid by actuation of the starter switch. The other end of the bell crank engages a pinion drive assembly mounted on the armature shaft of the motor and engages the pinion with an engine driving means when the plunger is drawn down into the series coil. An armature bypass switch is provided by means of which at least a portion of the current bypasses the armature until the pinion is engaged with the engine driving means, at which time the arm of the bell crank carrying the plunger opens the bypass switch allowing the current from the motor vehicle battery to pass through the armature.

This invention seeks to improve the above starter by providing a shunt coil, in addition to the series coil, around the opening in the frame into which the plunger is adapted to move. This shunt coil, in combination with the series coil, when energized, seals the plunger in the opening in the frame about which these coils are wound and consequently keeps the starter engaged at any normal operating load or speed since the intensity of the magnetic field about the opening created by the current flowing in these two coils is sufficient at any normal operating load or speed to seal the plunger in the opening against the frame.

The starter disclosed in my copending application is very satisfactory if the operator opens the starter switch when the engine fires, however, the present invention provides additional protective features which prevent damage to the starter if the operator keeps the starter switch closed for a brief period of time after the engine has been started.

In addition, the present invention utilizes the space between the end of the armature core and the ends of the armature coils by placing a flange which contacts the spring operating the pinion and a portion of the prongs of one arm of the bell crank which engage the flange, in this space when the starter is in a disengaged position. This results in an overall reduction in the length of the

starter mechanism, with attendant reduction in weight and cost.

An object of the present invention is the provision of a positive engagement starter which utilizes the magnetic field of the field coils to actuate the engagement mechanism.

A further object is to provide such a positive engagement starter which will remain engaged at any normal operating load or armature speed.

Another object is the provision of protective features for the electrical components of such a starter.

A further object of the invention is the utilization of the space between the end of the armature core and ends of the armature coils thereby effecting a reduction in the length, weight and cost of such a starter.

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

FIGURE 1 shows a side elevational view of an embodiment of the present invention with a portion cut away;

FIGURE 2 shows an end elevational view with a portion cut away;

FIGURE 3 is a longitudinal sectional view of the armature of the present invention;

FIGURE 4 is a schematic wiring diagram of one embodiment of the invention;

FIGURE 5 is a schematic wiring diagram showing the starter solenoid winding grounded through the armature circuit of the generator;

FIGURE 6 shows a modified armature bypass switch circuit which may be used with any of the embodiments of the invention;

FIGURE 7 is a schematic diagram of another embodiment of the invention in which the shunt field coil is connected as a short shunt;

FIGURE 8 is a schematic diagram of another embodiment of the invention in which the series field coils are connected differently from those shown in FIGURE 4, and,

FIGURE 9 is a schematic wiring diagram showing the starter solenoid winding grounded through a set of contact points.

Referring now to the drawings in which like reference numerals designate like parts throughout the several views thereof, there is shown in FIGURE 1 a starting motor generally designated by the numeral **11** having a frame **12** which includes end plates **13** and **14**. The end plates carry bearings **15** and **16** in which an armature shaft **17** is rotatably mounted. Positioned upon the armature shaft is a commutator **18**, a laminated armature core **21**, and armature coils **22**, the ends of which extend a considerable distance axially from the end of the armature core. As can be seen by reference to FIGURE 3, the armature shaft is provided with a helical splined portion **23** which terminates immediately adjacent the end of the laminated core **21**. Referring again to FIGURE 1, a helical splined barrel **24** is positioned over the splined portion of the armature shaft for engagement therewith. A collar **25** having a flange **26** extending radially therefrom is rotatably mounted upon said barrel. A pinion assembly **27** adapted for engagement with an engine driving means **28** such as a ring gear on the flywheel is rotatably mounted on the armature shaft **17**, and an overrunning clutch, the external portion of which is designated by the numeral **31**, is positioned between the helical splined barrel **24** and the pinion assembly **27**. A spring **32** is positioned over the helical splined barrel **24** so that it engages the flange **26** on collar **25** and a shoulder **33** of the pinion assembly.

A bell crank 34 having a linear arm 35, upon which is mounted a plunger 36, and an arcuate shaped arm 37 adapted to engage the flange 26 is pivotally mounted to the frame by means of a pin 38. As can best be seen by reference to FIGURE 2, the lower part of the arcuate shape arm has a bifurcated portion which divides the arm into two prongs 41 and 42 having slots 43 positioned therein (see FIGURE 1). The flange 26 is divided into a portion of reduced diameter 44 and a portion of unreduced diameter 45, thus forming shoulders 46 which fit into the slots 43 in the ends of the prongs 41 and 42. This prevents rotation of the collar and flange with respect to the prongs 41 and 42.

The bell crank 34 is spring loaded to the position shown in FIGURE 1, so that the pinion 27 is disengaged from the engine driving means 28, by means of a spring 47 positioned in a bore 48 in the end plate 13. This spring has a cap 51 which bears against the arcuate shaped arm 37 so that the center of the cap will always bear against the arm 37 thereby preventing cocking of the spring 47 in the bore 48.

A field winding 52 comprising a series winding 53 and a shunt or parallel winding 54 (see FIGURES 4, 7 and 8) is positioned around a core 55 in an opening in the frame 12. A switch actuator 56 is positioned to be engaged by the linear portion 35 of the bell crank as the plunger 36 moves into the core 55 upon energization of the starter. This arm opens an armature bypass switch 57 (see FIGURES 4, 6, 7 and 8) as will be explained subsequently. A housing cap 59 fits over the plunger 36 and bell crank arm 35 to prevent any foreign matter from entering the starter.

By utilizing the space between the end of the armature core 21 and the ends of the armature coils 22, it has been found that a starter mechanism for a given application, for example, a passenger automobile starter can be reduced in length by approximately 2½ inches and can be reduced in weight by approximately 3½ lbs. (from 22 to 18½ lbs.) over the starter disclosed in my copending application Serial Number 572,538, now Patent 2,813,206, issued November 12, 1957, and also over conventional starting motor mechanisms.

Referring now to FIGURE 4, which is a schematic of the starter of the present invention in the engaged position, there is shown in addition to the series coil 53 and shunt or holding coil 54, three additional series coils 58, 61 and 62. All of these coils are adapted to be energized by a battery 63 by means of a starter switch 64 which, when closed, energizes a solenoid winding 65 thereby moving the armature of the solenoid 66 so that the circuit between the battery and the coils is completed.

The holding coil 54 is connected as a long shunt across the starter that is from one terminal of the starter designated by the numeral 69 to the other terminal of the starter, which may be grounded as shown. The holding coil 54 together with series field coils 53, 58, 61 and 62, and the armature coils 22 are adapted to be energized by the battery through brushes 67 and 68, commutator 18 and brushes 71 and 72. In the embodiment shown in FIGURE 4, there is a connection 73 which connects three of the series coils 58, 61 and 62 in parallel with the series coil 53 and also provides a connection through bypass switch 57 to ground 77.

Prior to starting, the starter switch 64 is open, and the armature bypass switch 57 is closed. The operator closes the starter switch 64, thus energizing the solenoid winding 65 and completing the circuit from the battery to the series coils and the shunt coil. At this moment, the armature bypass switch 57 is closed, thus shorting out the relatively high impedance path through brushes 67 and 68, commutator 18, armature coils 22 and brushes 71 and 72 to ground, thereby permitting full battery current to flow in the field coils. This creates a magnetic field of high intensity about the series coil 53 and parallel or holding coil 54, thus pulling the plunger 36 down into the core 55 which is positioned around the opening in the frame 12 and engaging the pinion 27 with the engine driving means 28. As the bell crank 34 rotates, the linear portion 35 engages the switch actuator 56 thereby opening the armature bypass switch 57 thus sending full battery current through the armature coils to start the engine.

Provision of the shunt or holding coil 54 holds the plunger 36 in the opening against the frame thereby keeping the starter engaged and the armature bypass switch 57 open at any normal operating load or speed of the armature. When the engine has commenced running, it may impart to the armature through the drag in the overrunning clutch mechanism 37 sufficient speed to reduce the current flowing in the series coil 53 to the point where the plunger 36 would tend to move out of the core 55 and thus close the switch 57 if the series coil alone were acting. The magnetic field created by the current flowing in the shunt coil 54 prevents this action and holds the plunger sealed against the frame and the armature bypass switch open until the operator opens the starter switch 64, or one of the safety devices shown in FIGURE 5 or FIGURE 9 operates to deenergize the starter.

In order to balance the starting motor insofar as the magnetic flux produced by the series coil 53 and parallel or holding coil 54 in relation to the flux produced by the series field coils 58, 61 and 62 is concerned, it may be necessary to reduce the wire size of coil 53 from that used in series coils 58, 61 and 62, and to increase the number of turns over the number in series coils 58, 61 and 62.

FIGURE 7 shows another embodiment of the invention in which the shunt or holding coil 54 is connected between the connection 73 and ground across the armature of the starter thus providing a short shunt rather than a long shunt as used in the embodiment shown in FIGURE 4. The operation of the starter with the short shunt is nearly identical to that of the starter using the long shunt except that the short shunt will not be energized until the plunger 36 moves down into the core 55 a sufficient distance to permit the switch actuator 56 to open the armature bypass switch 57. This is true since the switch 57, in its closed position, shorts out the holding coil 54, however, the series coil 53 is capable, upon initial energization, of producing a magnetic field of sufficient intensity to draw the plunger 36 down into the core 55 a sufficient distance to cause the switch actuator 56 to open the switch 57.

Another practical way of connecting the series field coils is shown in FIGURE 8. Here, two of the series field coils 53 and 62 are connected in series and the other two series field coils 61 and 62 are connected in series, with the two groups connected in parallel. This is accomplished by moving the connection or terminal 73 from its position between coils 53 and 62 as shown in FIGURES 4 and 7 to a new position between the coils 61 and 62. In order, however, to maintain the magnetic polarity about the winding 62, the same as that shown in FIGURES 4 and 7, it is necessary to reverse the direction of the winding since the direction of current flow will be opposite from that flowing through the coil 62 as it is connected in FIGURES 4 and 7. It is obvious that the short shunt connection of the holding coil 54 could also be employed with this embodiment of the invention with the connection of the short shunt being made either between series coils 53 and 62 or between series coils 61 and 62.

FIGURE 5 shows an additional protective feature which can be provided for any of the embodiments of the starter mechanism of the present invention. Instead of directly grounding the winding 65 of the solenoid, it may be connected to terminal 74 of a generator 75. When the starter has been engaged and the motor started, the generator will produce a voltage which opposes that of the battery 63. It will be of sufficient magnitude to

reduce the current flowing in winding **65** to the point where the spring loaded solenoid will open and interrupt the current flowing from the battery to the starter. This provides a means for automatically disengaging the starter from the engine driving means entirely independent of the action of the operator and will disengage the starter even though the operator keeps the starter switch **64** closed after the engine has started. It also prevents the operator from accidentally engaging the starter when the engine is running.

FIGURE 9 shows a protective feature similar to that shown in FIGURE 5 which may be used with any of the embodiments of the invention illustrated in FIGURES 4, 7 and 8. Here the solenoid winding **65** is connected to a special pair of contact points **81** which can be readily added to the voltage regulator of the generator. These contacts are biased shut by means of a spring **82** thereby providing a connection to ground for the solenoid coil **65**. The regulator cutout winding **83** is connected to the terminal **74** of a generator at one end and to ground at the other end. When the starter switch **64** is closed, current flows from the battery **63** through solenoid winding **65** and contact points **81** to ground. This moves the armature of the starter solenoid **66** down to complete the circuit to the starter field coils and thus energizes the starter. When the engine starts and the generator produces current, the current flows through the regulator cutout winding **83** to ground thus opening the contacts **81**, interrupting the circuit through the solenoid coil **65** and deenergizing the starter. This provides an extremely reliable and fast acting means for deenergizing the starter when the engine has started since the contact points **81** will remain closed through the tension in the spring **82** until the spring force is overcome by the force of the magnetic field around the coil **83**. When the generator sends sufficient current through the coil **83**, the force of the spring **82** tending to hold the contact points **81** together will be overcome by the force created by the magnetic field of the coil **83** and the points will be opened almost instantaneously, thus deenergizing the starter almost instantaneously. As with the protective feature illustrated in FIGURE 5, grounding of the solenoid winding **65** through the contact points **81** also prevents the starter from being engaged when the engine is running, since the current flowing from the generator through the winding **83** will hold the contact points **81** open.

As shown in FIGURE 6, a resistance **76** may be placed between the connection **73** and armature bypass switch **57** so that a small amount of current flows through the armature coils prior to the opening of the switch **57**. This will turn the armature shaft **17** at a slow speed and low torque thereby facilitating engagement between pinion **27** and the engine driving means **28**. This feature may be used with any of the embodiments of the present invention.

Thus, the present invention provides a positive integral engagement starter in which the starter remains engaged and the armature bypass switch remains open at any normal load or speed of the armature, and in which the space between the ends of the armature core and the ends of the armature coils is effectively utilized, thereby reducing the length, weight and cost of the starter mechanism.

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.

I claim:

1. An internal combustion engine starter comprising a frame, a field coil supported on said frame, an armature shaft rotatably supported in said frame, an armature comprising a commutator, a core and armature coils positioned upon said armature shaft, said armature coils being positioned in coaxial spaced relation to said armature shaft and extending axially beyond the end of said armature core remote from said commutator, a pinion slidably mounted on the armature shaft and being engageable with crankshaft turning means, a flange slidably mounted on said armature shaft and positioned axially internally of the ends of said armature coils in the space between said coils and said shaft when said starter is in the disengaged position, a spring positioned around said armature shaft and intermediate said pinion and said flange, a bell crank pivotally mounted on said frame and having one arm of substantially arcuate configuration engaging said flange, a plunger affixed to the other arm of said bell crank, 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, said plunger being pulled through the frame and into the field coil when said field coil is energized whereby the arcuate shaped arm of the bell crank will move said pinion into engagement with said crankshaft turning means.

2. The internal combustion engine starter of claim 1 in which said bell crank is pivotally mounted on said frame intermediate the ends of the armature coils and said opening in said frame in the axial direction of said armature shaft.

3. An internal combustion engine starter assembly comprising a frame having an opening therein, a series field coil and a parallel field coil supported by said frame around said opening, 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, said bell crank being spring biased to move the plunger away from said opening and said field coils, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring, said plunger moving into said opening when said series and parallel field coils are energized, whereby the pinion will be moved into engagement with the crankshaft turning means and will remain engaged therewith under any normal load or speed of said armature while said series and parallel field coils are energized.

4. An internal combustion engine starter assembly comprising a frame having an opening therein, a plurality of series field coils connected in series with each other supported by said frame, at least one series field coil connected in parallel with said plurality of series field coils and supported by said frame around said opening, a parallel field coil supported by said frame around said opening, 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, said bell crank being spring biased to move the plunger away from said opening and said field coils supported by said frame around said opening, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring, said plunger moving into said opening when said series and parallel field coils are energized whereby the pinion will be moved into engagement with the crankshaft turning means and will remain engaged therewith under any normal load or speed of said armature while said series and parallel field coils are energized.

5. An internal combustion engine starter assembly comprising a frame having an opening therein, a plurality of series field coils connected in series with each other supported by said frame, at least one series field coil connected in parallel with said plurality of series field coils

and supported by said frame around said opening, a parallel field coil supported by said frame around said opening, an armature shaft rotatably supported in said frame, an armature comprising a commutator, a core, and armature coils positioned upon said armature shaft, said armature coils being positioned on said core in coaxial spaced relation to said armature shaft and extending axially beyond the end of said armature core remote from said commutator, an armature shaft pinion slidably mounted on the armature shaft and being engageable with crankshaft turning means, a flange slidably mounted on said armature shaft and positioned axially internally of the ends of said armature coils in the space between said armature coils and said armature shaft when said starter is in the disengaged position, a spring positioned around said armature shaft and intermediate said armature shaft pinion and said flange, a bell crank having one arm of substantially arcuate configuration pivotally mounted on said frame intermediate the ends of the armature coils and said opening in the axial direction of said armature shaft, said arm of substantially arcuate configuration engaging said flange, a plunger affixed to the other arm of said bell crank adjacent said opening when the starter is in the disengaged position, said plunger moving into the said opening when said series and parallel field coils are energized whereby the pinion will be moved into engagement with the crankshaft turning means and will remain engaged therewith under any normal load or speed of said armature while said series and parallel field coils are energized.

6. 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, said armature comprising a commutator, an armature core and armature coils, the armature coils being positioned in coaxial spaced relation to said armature shaft and extending axially beyond the end of said armature core remote from said commutator, an armature shaft pinion slidably mounted on the armature shaft and rotatably driven thereby, said pinion being engageable with a 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, the end of the bell crank adjacent the pinion and the end of the spring connected to the bell crank being positioned axially internally of the ends of the armature coils in the space between said coils and said shaft when said starter is in the disengaged position 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.

7. An internal combustion engine starter assembly comprising a frame having an opening therein, a series field coil and a parallel field coil supported by said frame around said opening, an armature rotatably mounted in said frame, an armature shaft supporting said armature, said armature comprising a commutator, an armature core and armature coils, the armature coils being positioned in coaxial spaced relation to said armature shaft and extending axially beyond the end of said armature core remote from said commutator, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said pinion being engageable with crankshaft turning means, a bell crank having one end adjacent said pinion and the other end attached to a plunger, said bell crank being spring biased to move the plunger away from said opening and said field coils, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring and positioned axially internally of the ends of the armature coils in the space between said coils and said shaft when said starter is in the disengaged position whereby the pinion will be moved into engagement with the crankshaft turning means when said plunger moves through the opening in the frame and into the field coils in response to the energization of said field coils.

8. The internal combustion engine starter assembly of claim 7 in which an electrical shunt normally short circuits the armature, said shunt being opened by the passage of the plunger into the field coils.

9. An internal combustion engine starter assembly comprising a frame having an opening therein, a series field coil and a parallel field coil supported by said frame around said opening, an armature rotatably mounted in said frame, an armature shaft supporting said armature, said armature comprising a commutator, an armature core and armature coils, the armature coils being positioned in coaxial spaced relation to said armature shaft and extending axially beyond the end of said armature core remote from said commutator, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said pinion being engageable with crankshaft turning means, a bell crank having one end adjacent said pinion and the other end attached to a plunger, said bell crank being spring biased to move the plunger away from said opening and said field coils, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring and positioned axially internally of the ends of the armature coils in the space between said coils and said shaft when said starter is in the disengaged position whereby the pinion will be moved into engagement with the crankshaft turning means when said plunger moves through the opening in the frame and into the field coils in response to the energization of said field coils, a battery, a solenoid comprising an armature and a winding, said field coils being electrically connectable to said battery through the armature of said solenoid, a generator, one end of the solenoid winding being connected to one terminal of the battery and the other connected to a terminal of the generator so that said solenoid winding is connected to the other terminal of said battery through said generator.

10. An internal combustion engine starter assembly comprising a frame having an opening therein, a series field coil and a parallel field coil supported by said frame around said opening, an armature rotatably mounted in said frame, an armature shaft supporting said armature, said armature comprising a commutator, an armature core and armature coils, the armature coils being positioned in coaxial spaced relation to said armature shaft and extending axially beyond the end of said armature core remote from said commutator, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said pinion being engageable with crankshaft turning means, a bell crank having one end adjacent said pinion and the other end attached to a plunger, said bell crank being spring biased to move the plunger away from said opening and said field coils, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring and positioned axially internally of the ends of the armature coils in the space between said coils and said shaft when said starter is in the disengaged position whereby the pinion will be moved into engagement with the crankshaft turning means when said plunger moves through the opening in the frame and into the field coils in response to the energization of said field coils, a battery, a solenoid comprising an armature and a winding, said field coils being electrically connectable to said battery through the armature of said solenoid, one end of the solenoid winding being connected to one terminal of the battery, a relay having a set of contact points and a winding, said set of contact points being normally biased to a closed position, the other end of said solenoid

winding being connected to the other terminal of said battery through said contact points, a generator, said generator being connected to the relay winding for energizing the winding when said engine is running thereby opening said contact points and de-energizing said solenoid and said starter field coils.

11. An internal combustion engine starter assembly comprising a frame, an armature including an armature shaft rotatably supported in said frame, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said frame having an opening with a series field coil and a parallel field coil positioned about said opening, a lever mechanism having a first portion positioned adjacent said pinion and a second portion positioned adjacent said opening, said second portion of said lever mechanism moving into said opening and said first portion of said lever mechanism moving said pinion axially upon said shaft into engagement with an engine turning means when said field coils are energized, said first portion of said lever mechanism holding said pinion engaged with said engine turning means under any normal load or speed of said motor due to the action of the magnetic field of said parallel field coil upon the second portion of said lever mechanism.

12. An internal combustion engine starter assembly comprising a frame having an opening therein, a series field coil and a parallel field coil supported by said frame around said opening, an armature rotatably mounted in said frame, an armature shaft supporting said armature, said armature comprising a commutator, an armature core and armature coils, the armature coils being positioned in coaxial spaced relation to said armature shaft and extending axially beyond the end of said armature core remote from said commutator, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said pinion being engageable with crankshaft turning means, a bell crank having one end adjacent said pinion and the other end attached to a plunger, said bell crank being spring biased to move the plunger away from said opening and said field coils, the end of the bell crank remote from the plunger and adjacent the pinion being connected to the pinion through a spring and positioned axially internally of the ends of the armature coils in the space between said coils and said shaft when said starter is in the disengaged position whereby the pinion will be moved into engagement with the crankshaft turning means when said plunger moves through the opening in the frame and into the field coils in response to the energization of said field coils, a battery, a solenoid comprising a solenoid armature and a solenoid winding, said field coils being electrically connectable to said battery through said solenoid armature when said solenoid winding is energized, said battery also being electrically connectable to energize said solenoid winding, a generator, and means connected to said generator for de-energizing said solenoid winding by means of the energy developed by said generator.

13. An internal combustion engine starter motor comprising a frame, a plurality of series field coils supported on said frame, a parallel field coil supported on said frame adjacent one of said series coils, driven means coupled to said motor, means having a first portion positioned adjacent said parallel field coil and said one of said series coils and a second portion positioned adjacent said driven means, said first portion being actuated by the magnetic field of said series field coils and said parallel field coil when the starter is energized so that said second portion moves said driven means into engagement with an engine turning means, said means maintaining said driven means in engagement with said engine turning means due to the action of the magnetic field of said parallel field coil under any normal load or speed of said motor.

14. An internal combustion engine starter motor comprising a frame, a plurality of series field coils supported on said frame, a parallel field coil supported on said frame adjacent one of said series coils, driven means coupled to said motor, means having a first portion positioned adjacent said parallel field coil and said one of said series coils and a second portion positioned adjacent said driven means, said first portion being actuated by the magnetic field of said series coils when the starter is energized so that said second portion moves said driven means into engagement with an engine turning means, said means maintaining said driven means in engagement with said engine turning means due to the action of the magnetic field of said parallel field coil under any normal load or speed of said motor.

15. An internal combustion engine starter motor comprising a frame, a plurality of series field coils supported on said frame, a parallel field coil supported on said frame adjacent one of said series field coils, said parallel field coil being connected as a short shunt in said starter motor, driven means coupled to said motor, means having a first portion positioned adjacent said parallel field coil and one of said series field coils and a second portion positioned adjacent said driven means, said first portion being actuated by the magnetic field of said series field coils when said starter is energized so that said second portion moves said driven means into engagement with an engine turning means, said means maintaining said driven means in engagement with said engine turning means due to the action of the magnetic field of said parallel field coil under any normal load or speed of said motor.

16. An internal combustion engine starter motor comprising a frame, a plurality of series field coils supported on said frame, a parallel field coil supported on said frame adjacent one of said series field coils, said parallel field coil being connected as a long shunt in said starter motor, driven means coupled to said motor, means having a first portion positioned adjacent said parallel field coil and said one of said series coils and a second portion positioned adjacent said driven means, said first portion being actuated by the magnetic field of said series field coils and said parallel field coil when the starter is energized so that said second portion moves said driven means into engagement with an engine turning means, said means maintaining said driven means in engagement with said engine turning means due to the action of the magnetic field of said parallel field coil under any normal load or speed of said motor.

17. An internal combustion engine starter motor comprising a frame, a series field coil supported upon said frame, driven means coupled to said motor, means having a first portion positioned adjacent said series field coil and a second portion positioned adjacent said driven means, said first portion being actuated by the magnetic field of said series field coil when said starter motor is energized so that said second portion moves said driven means relative to said frame, said driven means being adapted to come into engagement with an engine turning means, and a parallel field coil mounted upon said frame adjacent the first portion of said means, the magnetic field of said parallel field coil being adapted to hold said driven means in engagement with the engine turning means due to the action of the magnetic field upon the first portion of said means under any normal load or speed of the motor.

18. An internal combustion engine starter motor comprising a frame, a series field coil supported on said frame, a parallel field coil supported upon said frame adjacent said series field coil, driven means coupled to said motor, means having a first portion positioned adjacent said series field coil and said parallel field coil and a second portion positioned adjacent said driven means, said first portion being actuated by the magnetic field of at least one of said field coils when the starter is energized so that said second portion moves said driven means into engagement with an engine turning means, said means maintaining said driven means in engagement with said engine turning means due to the action of the magnetic

field of said parallel field coil under any normal load or speed of said motor.

19. An internal combustion engine starter assembly comprising a frame, a series field coil mounted upon said frame, an armature including an armature shaft rotatably supported in said frame, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said frame having an opening with said series field coil positioned about said opening, a parallel field coil also positioned about said opening, a lever mechanism having a first portion positioned adjacent said pinion and a second portion positioned adjacent said opening, said second portion of said lever mechanism moving into said opening and said first portion of said lever mechanism moving said pinion axially on said shaft into engagement with an engine turning means due to the action of the magnetic field of at least one of said field coils upon the second portion of said lever mechanism when said starter assembly is energized, said first portion of said lever mechanism holding said pinion engaged with said engine turning means under any normal load or speed of said motor due to the action of the magnetic field of said parallel field coil upon the second portion of said lever mechanism.

20. An internal combustion engine starter assembly comprising a frame, a plurality of series field coils mounted upon said frame, an armature including an armature shaft rotatably supported in said frame, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said frame having an opening with one of said series field coils positioned about said opening, a parallel field coil also positioned about said opening, a lever mechanism having a first portion positioned adjacent said pinion and a second portion positioned adjacent said opening, said second portion of said lever mechanism moving into said opening and said first portion of said lever mechanism moving said pinion axially upon said shaft into engagement with an engine turning means when said series field coils are energized, said first portion of said lever mechanism holding said pinion engaged with said engine turning means under any normal load or speed of said starter assembly due to the action of the magnetic field of said parallel field coil upon the second portion of said lever mechanism.

21. An internal combustion engine starter assembly comprising a frame, a plurality of series field coils mounted upon said frame, an armature including an armature shaft rotatably supported in said frame, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said frame having an opening with one of said series field coils positioned about said opening, a parallel field coil connected as a long shunt also positioned about said opening, a lever mechanism having a first portion positioned adjacent said pinion and a second portion positioned adjacent said opening, said second portion of said lever mechanism moving into said opening and said first portion of said lever mechanism moving said pinion axially upon said shaft into engagement with an engine turning means when said series field coil and said parallel field coil are energized, said first portion of said lever mechanism holding said pinion engaged with said engine turning means under any normal load or speed of said motor due to the action of the magnetic field of said parallel field coil upon the second portion of said lever mechanism.

22. An internal combustion engine starter assembly comprising a frame, a plurality of series field coils mounted upon said frame, an armature including an armature shaft rotatably supported in said frame, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said frame having an opening with one of said series field coils positioned about said opening, a parallel field coil connected as a short shunt also positioned about said opening, a lever mechanism having a first portion positioned adjacent said pinion and a second portion positioned adjacent said opening, said second portion of said lever mechanism moving into said opening and said first portion of said lever mechanism moving said pinion axially upon said shaft into engagement with an engine turning means when said series field coils are energized, said first portion of said lever mechanism holding said pinion engaged with said engine turning means under any normal load or speed of said motor due to the action of the magnetic field of said parallel field coil upon the second portion of said lever mechanism.

23. An internal combustion engine starter assembly comprising a frame, a plurality of series field coils mounted upon said frame, an armature including an armature shaft rotatably supported in said frame, an armature shaft pinion slidably mounted on said armature shaft and rotatably driven thereby, said frame having an opening with one of said series field coils positioned about said opening, a parallel field coil also positioned about said opening, a lever mechanism having a first portion positioned adjacent said pinion and a second portion positioned adjacent said opening, said second portion being constructed of a ferromagnetic material, said second portion of said lever mechanism moving into said opening and said first portion of said lever mechanism moving said pinion axially upon said shaft into engagement with an engine turning means when said series field coils are energized, said first portion of said lever mechanism holding said pinion engaged with said engine turning means under any normal load or speed of said starter assembly due to the action of the magnetic field of said parallel field coil upon the second portion of sad lever mechanism.

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