March 31, 1931. J. B. DYER 1,799,042

ENGINE STARTING APPARATUS

Filed Oct. 24, 1928 3 Sheets-Sheet 1

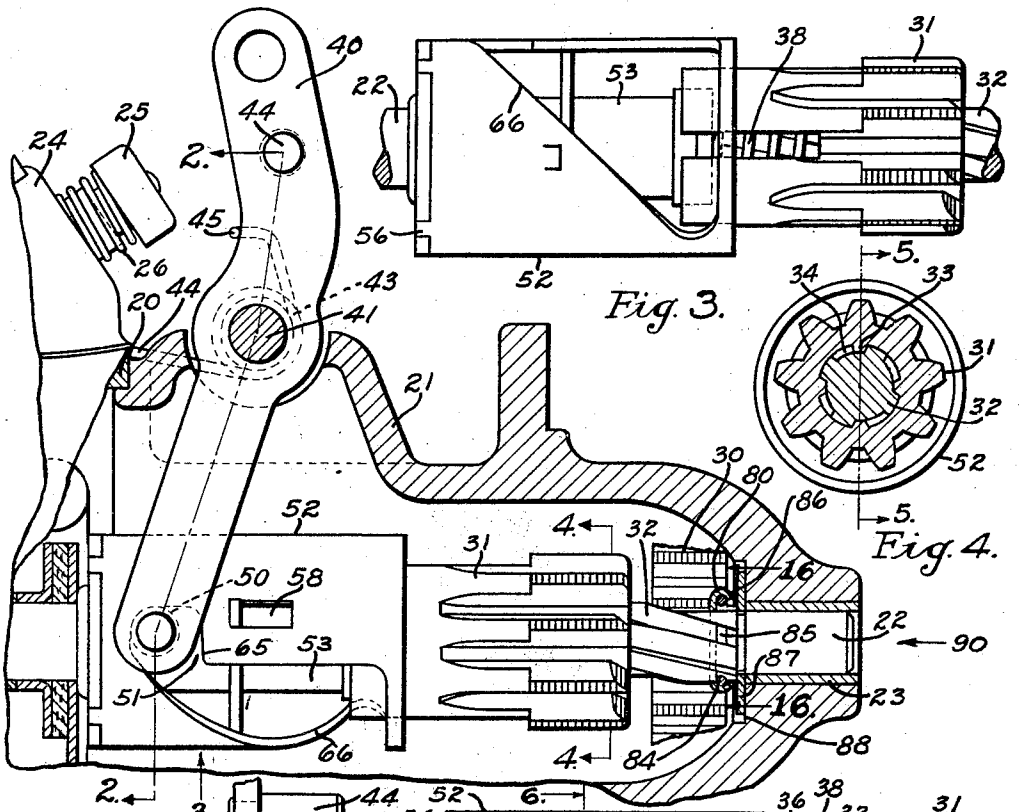


Fig. 1.

Fig. 3.

Fig. 4.

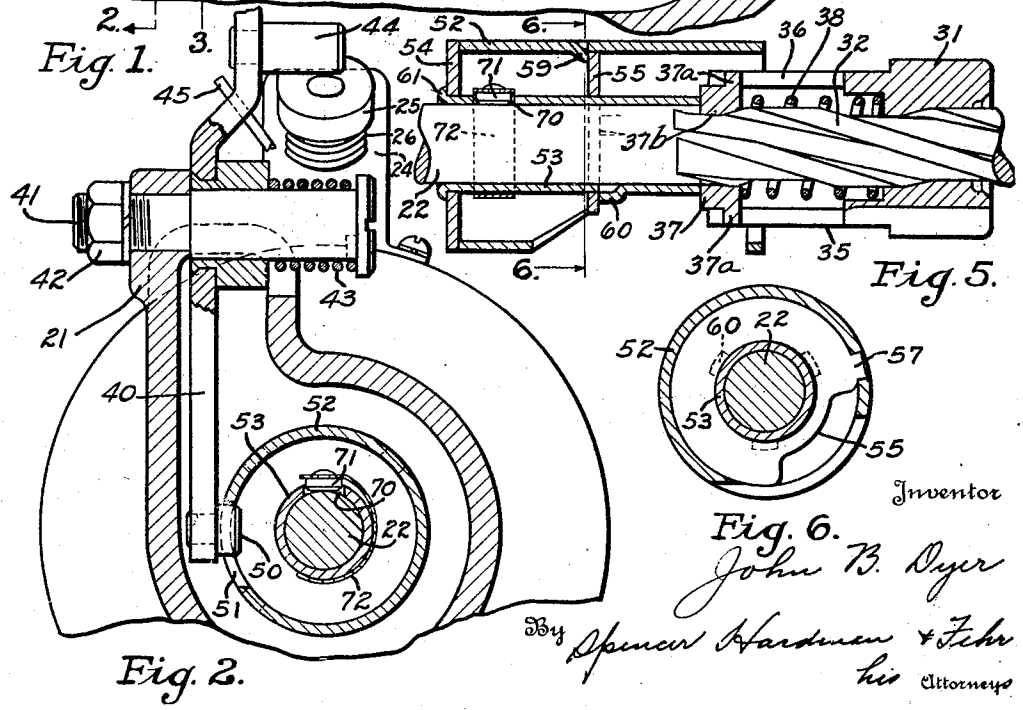


Fig. 5.

Fig. 6.

Fig. 2.

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March 31, 1931. J. B. DYER 1,799,042

ENGINE STARTING APPARATUS

Filed Oct. 24, 1928 3 Sheets-Sheet 2

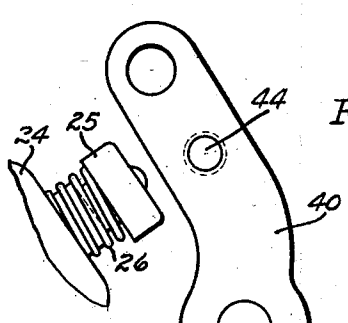


Fig. 10.

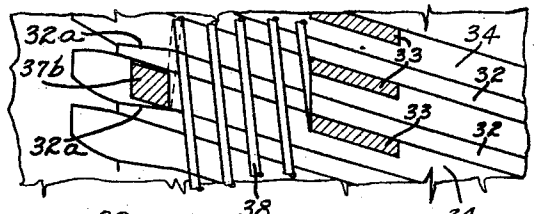
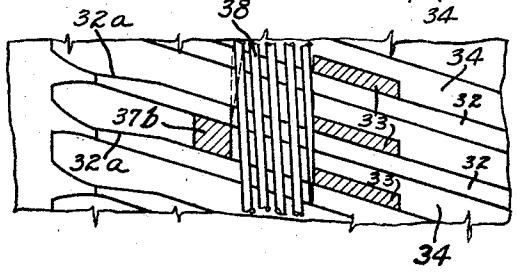


Fig. 11.



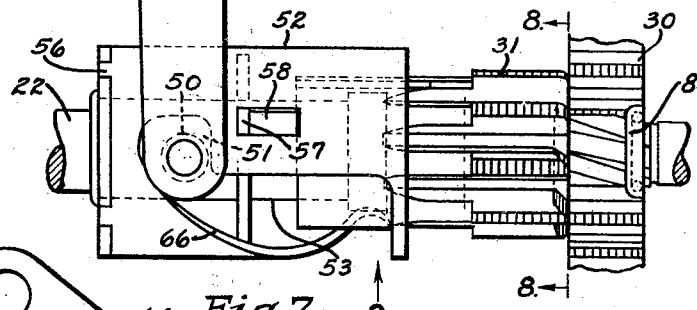


Fig. 7.

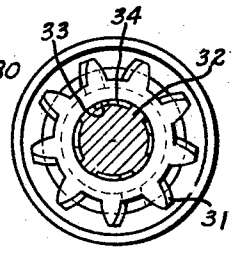
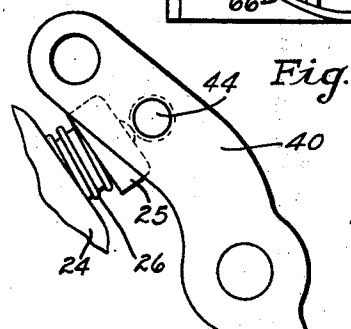


Fig. 8.



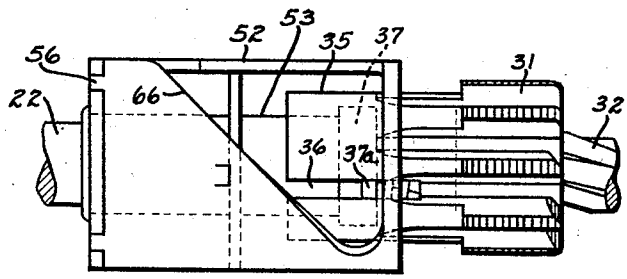


Fig. 9.

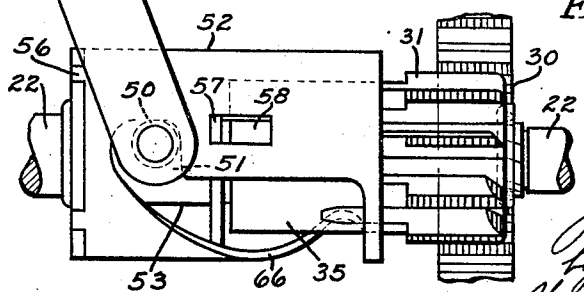


Fig 12.

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ENGINE STARTING APPARATUS

Filed Oct. 24, 1928 3 Sheets-Sheet 3

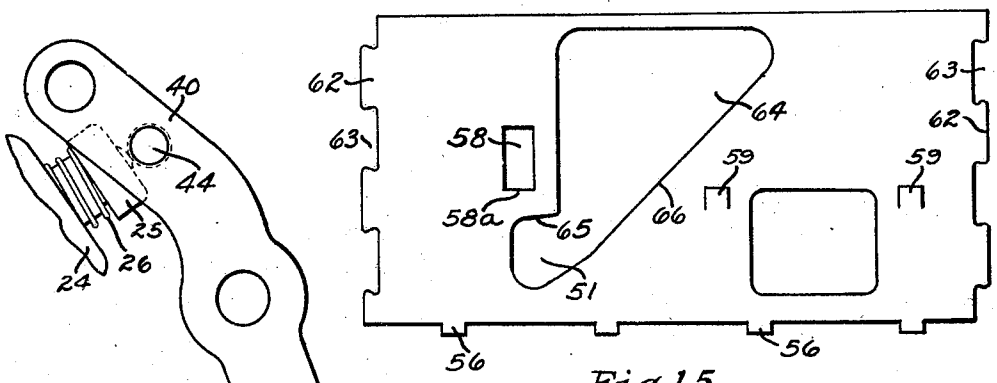


Fig.15.

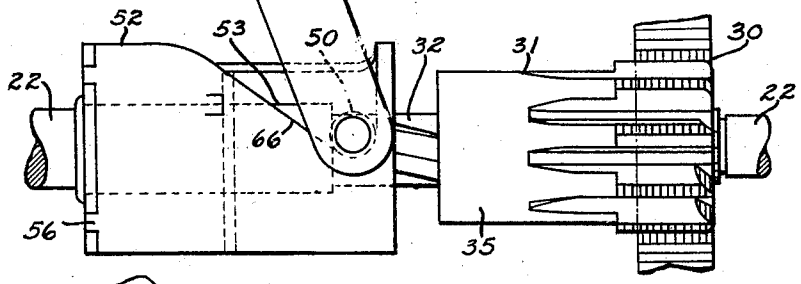


Fig.13.

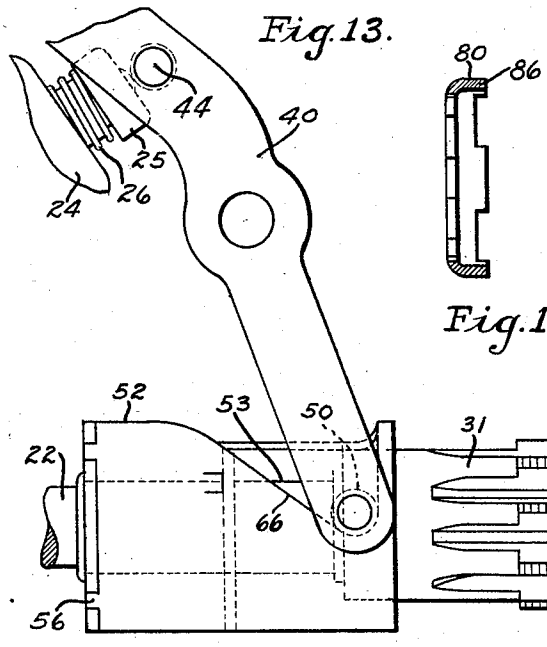


Fig.14.

Fig.17.

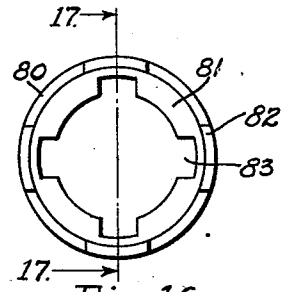


Fig.16.

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1,799,042

UNITED STATES PATENT OFFICE

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ENGINE-STARTING APPARATUS

Application filed October 24, 1928. Serial No. 314,809.

This invention relates to apparatus for starting an internal combustion engine, and particularly to the type of apparatus which comprises an electric motor and means for connecting the motor with a gear of the engine to be started, and including a pinion and provisions whereby the pinion will be automatically demeshed from the engine gear when the engine starts.

Examples of engine starters of this type are disclosed in the copending applications of I. J. Reuter, Serial No. 289,162, filed June 29, 1928, F. J. Hardman, Serial No. 728,531, filed July 28, 1924, and J. B. Dyer, Serial No. 258,071, filed February 29, 1928. The engine starters disclosed in these applications include manually operable means for moving the pinion into mesh with the engine gear and for closing the motor circuit only after the pinion has been substantially meshed with the engine gear, said manually operable means including provisions for causing the pinion to rotate while being yieldingly pressed against the engine gear in order to facilitate gear meshing in case the pinion should abut the engine gear before going into mesh.

One of the objects of the present invention is to simplify the construction of and to reduce the cost of manufacture of engine starting apparatus of this type, and this aim is accomplished by connecting the pinion and motor shaft by a lost motion spline connection which will permit manually rotating the pinion sufficiently to effect a gear meshing registration.

In the disclosed form of the present invention, the pinion has a lost motion driving connection with helical splines provided on the motor driven shaft. A pinion shifter is slidable along the shaft and is connected preferably with the helical splines thereof so that axial movement of the shifter is accompanied by rotation thereof. Connections are provided between the shifter and pinion so that the pinion will rotate with the shifter, and these connections provide for relative axial movement between the pinion and shifter so that in case motion of the pinion into mesh with the engine gear is arrested by the pinion teeth abutting the engine gear teeth, the shifter may continue to move axially in order to rotate the pinion into meshing relation with the engine gear. Axial movement is transmitted from the shifter to the pinion through a spring so that the shifter will be held normally the required distance away from the pinion and so that the pinion will be yieldingly pressed against the engine gear teeth while being rotated. The pinion shifter is manually operated by a pedal or other suitable device which is automatically disconnected from the shifter before the engine starts so that after the engine becomes self-operative, the pinion may be automatically demeshed regardless of the status of the pedal.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a fragmentary view, partly in longitudinal section, of an engine starting apparatus embodying the present invention.

Fig. 2 is a sectional view on line 2—2 of Fig. 1.

Fig. 3 is a bottom view of a portion of the apparatus, looking in the direction of the arrow 3 of Fig. 1.

Fig. 4 is a sectional view on the line 4—4 of Fig. 1.

Fig. 5 is a longitudinal, sectional view of a portion of the apparatus, this section being taken on a vertical plane as indicated by the line 5—5 of Fig. 4.

Fig. 6 is a sectional view on the line 6—6 of Fig. 5.

Fig. 7 is a diagrammatic view of parts shown in Fig. 1, and shows the condition of the apparatus at the instant the motor pinion has been rotated into meshing registration with the gear of the engine.

Fig. 8 is a sectional view on the line 8—8 of Fig. 7.

Fig. 9 is a bottom view of certain parts shown in Fig. 7, this view being taken in the direction of arrow 9 of Fig. 7.

Figs. 10 and 11 are development views of certain parts shown in Figs. 1 and 7 respectively, Fig. 10 showing these parts in normal position, and Fig. 11 showing the same parts corresponding to the position shown in Fig. 7.

Fig. 12 is a view similar to Fig. 7, but shows the apparatus in position just prior to closing the motor switch.

Fig. 13 is a view similar to Fig. 12, showing the condition of the apparatus during the cranking operation.

Fig. 14 is a view similar to Fig. 13, showing the starting apparatus after the engine has become self-operative and before the operator has released the pedal.

Fig. 15 is a plan view of a sheet metal blank used to form a sleeve employed to transmit motion from the pedal to the pinion shifter.

Fig. 16 is a double size view of a pinion thrust washer, this view being taken in the plane of the line 16—16 of Fig. 1.

Fig. 17 is a sectional view on the line 17—17 of Fig. 16.

Referring to the drawings, 20 designates the field frame of an electric motor which is secured to a gear housing 21 adapted to be attached to an engine frame not shown. The frame 20 carries a bearing, not shown, for supporting the left end of a motor armature shaft 22, and the frame 21 provides a bearing 23 for said shaft. The motor circuit is controlled by a switch having a casing 24, a fragment of which is shown in Fig. 1. The casing 24 encloses contacts, one of which is movable by a switch plunger 25 normally held in switch-open position by a spring 26. The means for connecting the shaft 22 with the flywheel 30 of an engine to be started comprise a pinion 31 and provisions for automatically causing the pinion to be demeshed from the gear 30 when the engine starts. These provisions result from employing helical splines 32 on the shaft 22 for driving the pinion 31. On referring to Fig. 4, it will be noted that the internal helical splines 33 of pinion 31 are substantially narrower than the helical grooves 34 between the splines 32 of the shaft 22. This construction provides what is designated a lost motion helical spline connection between the shaft and pinion. Normally the splines of the pinion are spaced from the driving side of the splines of the shaft and are normally maintained in engagement with the demeshing sides of the splines of the shaft. This normal relation between the pinion and shaft will be described when describing the pinion shifter.

The pinion shifter 37 is a disc-like body having internal splines which cooperate with the splines of the shaft with relatively little lost motion. Therefore, axial movement of the shifter along the shaft will be accompanied by rotary motion of the shifter. Rotary motion of the shifter is imparted to the pinion 31 by providing the pinion with a tubular extension 35 having diametrically opposite grooves 36, each receiving a tang 37*a* extending from the shifter 37. Motion is imparted from the shifter 37 axially to the pinion 31 by a spring 38 encircling the shaft 22 and located between the shifter 37 and the pinion 31. Thus it will be seen that motion of the shifter 37 axially toward the gear 30 will cause the pinion 31 to be yieldingly urged toward the gear and in case of gear tooth abutment, the pinion 31 will be yieldingly pressed by the spring 38 against the gear while the shifter 37 continues to move axially along the shaft in order to rotate the pinion into meshing registration with the engine gear. It is desirable that the pinion be yieldingly pressed against the engine gear while being rotated for the reason that a yielding pressure will permit the pinion to recede along the shaft slightly while being rotated in engagement with the end face of a gear tooth. If the pinion were not permitted to recede slightly it might become interlocked with the engine gear due to the engagement of roughened surfaces at the ends of the abutting pinion and gear teeth.

The spring 38 is normally in a state of compression as shown in Fig. 5 and the means for preventing separation of the pinion from the shifter to a greater extent than shown in Fig. 5, includes the motor shaft itself. It will be noted that the spring 38 tends to urge the shifter 37 axially toward the left and the pinion 31 axially toward the right as viewed in the drawings. Due to the connection between the shifter and pinion provided by the tangs 37*a* and grooved tubular extension 36, relative endwise movement between the pinion and shifter can take place only axially of the shaft. Therefore the helical splines 32 of the shaft cooperate with the helical splines of the shifter and pinion to limit separation of these two elements. It is apparent from Fig. 10 that the spring 38 tends to move the helical splines 37*b* of the shifter 37 only in an axial direction until they engage one side of the shaft splines 32. The spring 38 urges the splines 33 of the pinion only in an axial direction until they engage the demeshed sides of the splines 32 of the shaft. Therefore, no other means are required to limit separation of the pinion and shifter while these elements are mounted upon the shaft.

The shifter splines 37*b* are normally yieldingly pressed against portions 32*a* of the shaft splines, which portions are inclined at a smaller angle to the shaft axis than other portions of the splines. This construction provides means for locking the pinion 31 to the shaft 22 in such a way that it cannot be moved toward the engine gear unless the shifter 37 be moved toward the engine gear. It is apparent from Fig. 10 that, if one were to take hold of the pinion 31 and pull it to-

ward the right, resistance would be offered immediately due to the fact that the shifter and pinion are so connected that one cannot be moved helically without moving the other and that movement of the pinion splines 33 helically along a shaft spline portion of one lead or pitch cannot take place while the splines 37*b* of the shifter attempt to move along a shaft spline portion of a different pitch. In other words, it is apparent that if one were to attempt to slide the pinion splines 33 along the shaft splines 32 toward the right as viewed in Fig. 10, these pinion splines will become tightly wedged against the shaft splines due to the fact that the shifter splines 37*b*, while engaging the shaft splined portion 32*a*, will prevent rotary motion of the pinion. Therefore, while the shifter 37 remains in normal position, the pinion will not drift accidentally into mesh with the engine gear.

The manually operable means for actuating the pinion shifter 37 includes a lever 40 adapted to be operated by a pedal not shown and pivoted upon a stud 41 attached by a nut 42 to the gear housing 21 as shown in Fig. 2. The lever 40 is normally maintained in the position shown in Fig. 1 by a spring having its intermediate portion 43 coiled around the stud 41 and having end portions 44 and 45 engaging respectively the housing 21 and the lever 40. The spring 43 is so biased as to urge the lever 40 in a clockwise direction. The lever 40 carries a stud 44 adapted to engage the switch plunger 25.

Motion is transmitted from the lever 40 to the shifter 37 by devices which are disconnectible in response to the operation of the starter while cranking the engine. These devices comprise a stud 50 attached adjacent the lower end of the lever 40 and normally received by a notch 51 in a sleeve 52 which is mounted concentrically upon a hub 53. The hub 53 supports discs 54 and 55 which space the sleeve 52 from the hub 53. The disc 54 is provided adjacent its periphery with notches which receive tangs 56 extending from the sleeve 52. Thus relative movement between the sleeve 52 and the disc 54 is limited in one direction toward the interior of the sleeve or toward the disc 55. The disc 55 is provided as shown in Fig. 6 with a tang 57 which is received by an opening 58 in the sleeve 52 and which, when assembled, bears against the edge surface 58*a* (see Fig. 15). The sleeve 52 is provided with tangs 59 bent inwardly to provide stops also for engaging that surface of the disc 55 which faces the disc 54. Thus when the sleeve 52 and the disc 55 are assembled, relative motion between them is limited in one direction so that the disc 55 cannot be moved toward the disc 54 after it has been assembled and engages the tangs 59 and the edge surface 58*a* of the opening 58 in the sleeve 52. The hub 53 which is made of tubing or by rolling up a piece of flat stock is provided with outwardly bent tangs 60. The hub 53 is passed through central aligned openings in the discs 55 and 54 until its tangs 60 engage the right hand surface of the disc 55. Then obviously the hub 53 cannot be moved any further through the discs 55 and 54. After these parts have been thus assembled, the end edge 61 of the hub 53 is deformed by spinning or swedging against the left hand face of the disc 54. Thus the sleeve 52, hub 53 and discs 54 and 55 are permanently maintained in assembled relation. The sleeve 52 is formed preferably from the blank shown in Fig. 15 which is provided with interlocking dovetail tangs and notches 62 and 63 which are interlocked to maintain the blank in cylindrical form. The notch 51 may be considered as an extension from a substantially triangular opening 64 which is defined particularly by an edge surface 65 and an edge surface 66 both of which are oblique to the axis of rotation of the sleeve 52. The edge surface 65 of the assembled sleeve 52 is at an angle of 3 to 4 degrees with a plane perpendicular to the axis of the shaft 22 while the edge surface 66 is located at a much greater angle.

In order to increase the frictional engagement between the shaft 22 and the sleeve 52, the hub 53 with which the sleeve 52 is drivingly connected is provided with an opening 70 which receives a button 71 yieldingly urged against the shaft 22 by a leaf spring 72 so shaped as to retain the button 71 within the opening 70 whether the hub 53 be mounted upon the shaft to be removed therefrom.

While the pinion is driving the engine gear 30 it engages a thrust collar 80 which is more clearly shown in double scale in Figs. 16 and 17. The thrust collar 80 includes a plane portion 81 and a peripheral portion 82. The plane portion is provided with a central aperture adapted to receive the splined shaft 22. Those parts of the plane portion 81 between the notches 83 which receive the shaft spline 32 are adapted to bear against a wire split ring 84 received by a groove 85 in the shaft 22. The peripheral portion 82 is provided with tangs 86 which are bent around the wire 84 as shown in Fig. 1 after the thrust collar 80 has been assembled. End thrust from the shaft is transmitted to the gear housing 21 by a plane washer 87 which engages a finished surface 88 provided by the housing adjacent the left end of the bearing 23.

The operation of the engine starter is as follows:

The lever 40 is moved in a counterclockwise direction thereby causing the stud 50 to move toward the right along the shaft 22 and to cause the sleeve 52 to move in the same direction in order to move the pinion shifter 37 toward the engine gear 30. While the

pinion is being moved into mesh with the engine gear and before the motor switch is closed, the edge surface 65 defining the notch 51 in the sleeve 52 is engaged by the stud 50. In case motion of the pinion toward the right is arrested by the engagement of its teeth with the teeth of the gear, continued counterclockwise movement of the lever 40 will cause the pinion shifter 37 to move in a helical path about the shaft 22 while the pinion 31 is being yieldingly pressed by the spring 38 against the engine gear. During the movement of the lever 40 from the position shown in Fig. 1 to that shown in Fig. 7, the pinion will be rotated from the position shown in Fig. 4 to the position shown in Fig. 8 and its internal helical splines will be transferred from the demeshing sides of the shaft splines 32 as shown in Fig. 10 to the driving sides of the shaft splines as shown in Fig. 11. This amount of preliminary rotation of the pinion will be sufficient to cause its teeth to be registered for meshing with the engine gear. Fig. 7 shows the apparatus just at the instant the pinion is ready to mesh with the engine gear. Fig. 11 which corresponds to Fig. 7 shows that the shifter splines 37*b* have been moved considerably closer than normal to the pinion 31. Therefore the spring 38 will be considerably more compressed at the instant the pinion has been turned for meshing with the engine gear. When this condition is brought about the spring 38 will be released in order to cause the pinion to move forward into mesh with the engine gear. If the lever 40 remained fixed during this spring operated movement of the pinion, the pinion would move into mesh with the engine gear until its internal splines are in contact with the demeshing sides of the shaft splines. By the time the lever 40 has been moved into the position shown in Fig. 12, just prior to closing the switch, the pinion will have been rotated until its splines 33 are engaged by the driving sides of the shaft splines 32.

Further movement of the lever 40 in a counterclockwise direction from the position shown in Fig. 12 toward that shown in Fig. 13 will cause the stud 44 of the lever 40 to push the switch plunger 25 into switch closed position. This will cause the motor to turn the shaft 22 and the pinion 31 to drive the engine gear 30. The driving direction of rotation of the shaft 22 is clockwise as viewed from the right hand end looking in the direction of arrow 90 in Fig. 1. While the engine is being cranked, the shaft 22 will rotate the sleeve 52 in the same direction by virtue of a frictional drag between these parts in order to withdraw the notch 51 from the stud 50 and to cause the oblique edge surface 66 to engage the stud 51. Due to the engagement of the surface 66 with the stud 51 while the sleeve 52 is rotating, the sleeve will be cammed toward the left as viewed in the drawings, from the position shown in Fig. 12 to that shown in Fig. 13. Consequently, the hub 53 of the sleeve 52 will be retracted from the pinion shifter 37 so that the pinion together with its shifter may be moved toward the left free of obstruction when the pinion is automatically demeshed from the engine gear when the engine starts. Hence automatic demeshment of the pinion may take place regardless of the status of the lever 40. After the starting operation, the operator will release the lever 40 to permit the spring 43 to restore the lever to the position shown in Fig. 1. During clockwise movement of the lever 40 toward normal position the stud 51 carried by it will engage the inclined surface 66 provided by the sleeve 52, in order to cause the sleeve to be rotated again to normal position so that the notch 51 will again rceive the stud 50. Therefore it is apparent that the operator must permit the lever 40 to be returned to normal position before the starting operation can be repeated.

During the operation of demeshing the pinion, the pinion will be whirled with considerable force in a helical path out of mesh with the engine gear and the pinion shifter will be moved with the pinion in substantially the same path until it engages the sleeve hub 53. Due to its greater momentum, the pinion 31 may move further toward the left before coming to rest thereby compressing the spring 38 slightly beyond its normal state of compression. When the momentum of the whirling pinion is taken up by compression of the spring 38, the spring 38 will rebound to throw the pinion back into normal position as shown in Fig. 10. There will be no tendency for the shifter 37 to rebound after striking the hub 53 because it is being followed up by the pinion and compressed spring 38. In the normal position of the shifter 37 its splines 37*b* have a slight amount of lost motion with respect to the shaft splines 32. Hence when the shifter 37 is restored to normal position, its splines 37*b* will be sure to recede from the pinion splines 33 sufficiently to engage those portions 32*a* of the shaft splines which are inclined to the shaft axis at a different angle from other portions of the shaft splines. In other words, there should be sufficient lost motion to insure that the shifter splines 37*b* move a substantial distance toward the left from the junction of the shaft spline portions 32*a* with portions to the right thereof. This construction therefore insures that there will always be such cooperation between the shifter splines 37*b* and shaft spline portions 32*a* that the pinion 31 will be locked to the shaft until released by movement of the shifter 37 toward the right.

The present invention embodies the essential features of the inventions disclosed in

the applications referred to, in that the meshing of the pinion with the engine gear is accomplished by manual effort before the motor switch is closed so that damage to the gear teeth will be minimized, and in that the pinion is automatically demeshed regardless of the status of the operating lever, thereby dispensing with the use of an overrunning clutch between the pinion and motor shaft. The present invention constitutes an improvement over the copending application, Serial No. 258,071 particularly with respect to the fact that the pinion is directly driven by the motor shaft and not by an intermediate element which constitutes part of the means for rotating the pinion while it is being pressed against the engine gear. By providing the lost motion spline connection between the pinion and shaft, the pinion may be directly driven by the shaft and the lost motion will permit rotating the pinion relative to the shaft in order that gear meshing will be facilitated. The pinion shifter, since it does not transmit cranking torque from the motor to the pinion, but is only used to turn the pinion manually, may be made very cheaply. The cost of construction is reduced also since means other than the shaft itself are not required for limiting the separation of the shifter from the pinion. Also due to this feature, the assembling of the shifter and pinion together upon the shaft has been greatly facilitated.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; and pinion shifting means constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion.

2. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; and pinion shifting means constructed to urge the pinion against the gear with yielding pressure and to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion.

3. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially of the shaft and connected with the pinion to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator for moving the shifter; and means for automatically disconnecting the actuator from the shifter before the engine starts.

4. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially of the shaft and connected with the pinion to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a spring tranmitting axial movement from the shifter to the pinion; and means for operating the shifter.

5. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially of the shaft and connected with the pinion to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a spring transmitting axial movement from the shifter to the pinion; a manually operable actuator for moving the shifter; and means for automatically disconnecting the actuator from the shifter before the engine starts.

6. Engine starting apparatus comprising, in combination, a drive shaft, a pinion shiftable axially of the shaft and connected thereto by a lost motion connection, a shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, and means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with a gear of the engine to be started.

7. Engine starting apparatus comprising, in combination, a drive shaft, a pinion shiftable axially of the shaft, and connected thereto by a lost motion connection, a shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, a spring rendered operative by longitudinal movement of the shifter for yieldingly urging the pinion toward a gear of the engine to be started; and means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear.

8. Engine starting apparatus comprising, in combination, a drive shaft, a pinion shiftable axially of the shaft and connected thereto by a lost motion connection, a shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, a spring for transmitting movement from the shifter longitudinally to the pinion for yieldingly urging the pinion against a gear of the engine to be started in case of tooth abutment; and means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear.

9. Engine starting apparatus comprising, in combination, a drive shaft, a pinion shiftable axially of the shaft and connected thereto by a lost motion connection, a shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, a normally compressed spring between the shifter and pinion for transmitting movement from the shifter longitudinally to the pinion for yieldingly urging the pinion against a gear of the engine to be started in case of tooth abutment; means limiting separation of the pinion from the shifter; and means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear.

10. Engine starting apparatus comprising, in combination, a drive shaft, a pinion shiftable axially of the shaft and connected thereto by a lost motion connection, a shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, a normally compressed spring between the shifter and pinion for transmitting movement from the shifter longitudinally to the pinion for yieldingly urging the pinion against a gear of the engine to be started in case of tooth abutment; means provided by the shaft for limiting separation of the pinion from the shifter; and means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear.

11. Engine starting apparatus comprising, in combination, a drive shaft, a starter pinion movable along the shaft into mesh with a gear of the engine to be started, means for shifting the pinion, and means for locking the pinion to the shaft, said means being unlocked only by operation of the shifting means prior to the movement of the pinion toward the engine gear.

12. Engine starting apparatus comprising, in combination, a splined drive shaft, a starter pinion movable along the shaft into mesh with a gear of the engine to be started, means for shifting the pinion, and means for wedging the pinion against the splines of the shaft to prevent movement of the pinion toward the engine gear, said wedging means being released only by operation of the shifting means.

13. Engine starting apparatus comprising, in combination, a motor, a helically splined shaft operated by the motor, a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started, and pinion shifting means constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion.

14. Engine starting apparatus comprising, in combination, a motor, a helically splined shaft operated by the motor, a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started, and means for shifting the pinion into mesh with the engine gear and operable in case of gear tooth abutment to apply pressure yieldingly between the pinion and engine gear while turning the pinion into meshing registration and taking up lost motion between the pinion and shaft.

15. Engine starting apparatus comprising, in combination, a motor, a helically splined shaft operated by the motor, a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started, a pinion shifter movable longitudinally of the shaft and so connected therewith that longitudinal movement of the shifter effects rotation thereof, means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing, and means for operating the shifter.

16. Engine starting apparatus comprising, in combination, a motor, a helically splined shaft operated by the motor, a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started, a pinion shifter mounted upon the shaft and helically splined thereto whereby longitudinal movement of the shifter effects rotation thereof, means connecting the shifter and pinion so that the pinion will be initially rotated to

facilitate meshing, and means for operating the shifter.

17. Engine starting apparatus comprising, in combination, a motor, a helically splined shaft driven thereby, a pinion and a pinion shifter mounted upon said shaft and connected with said splines, the pinion having a lost motion driven connection with the shaft splines and movable into mesh with a gear of an engine to be started, a spring transmitting motion from the shifter to the pinion whereby the pinion will be yieldingly pressed against the gear in case of gear tooth abutment prior to meshing, means transmitting rotary movement from the shifter to the pinion, and means for operating the shifter.

18. Engine starting apparatus according to claim 17 in which those portions of the shaft splines normally engaged by the shifter are inclined relative to the shaft at an angle differing from the angular inclination of the shaft spline portions engageable with the pinion whereby separation of the pinion from the shifter is limited and the pinion is prevented from moving toward the engine gear unless actuated by the shifter.

19. Engine starting apparatus comprising, in combination, a motor, means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; pinion shifting means constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifting means, means for automatically moving the element connected with the shifting means away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

20. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; pinion shifting means constructed to urge the pinion against the gear with yielding pressure and to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifting means; means for automatically moving the element connected with the shifting means away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

21. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially on the shaft and so connected with the shaft that axial movement is accompanied by rotary movement, and connected with the pinion to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter; means for automatically moving the element connected with the shifter away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

22. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement; a spring rendered operative by longitudinal movement of the shifter for yieldingly urging the pinion toward the engine gear; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear, said connecting means permitting the shifter to move axially relative to the pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter; means for automatically moving the element connected with the shifter away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

23. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be

started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, a normally compressed spring between the shifter and pinion for transmitting movement from the shifter longitudinally to the pinion for yieldingly urging the pinion against a gear of the engine to be started in case of tooth abutment; means limiting separation of the pinion from the shifter; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter; means for automatically moving the element connected with the shifter away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

24. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; pinion shifting means constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifting means; means responsive to the operation of the starting motor for automatically moving the element connected with the shifting means away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

25. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; pinion shifting means constructed to urge the pinion against the gear with yielding pressure and to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifting means; means responsive to the operation of the starting motor for automatically moving the element connected with the shifting means away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

26. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially on the shaft and so connected with the shaft that axial movement is accompanied by rotary movement, and connected with the pinion to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter; means responsive to the operation of the starting motor for automatically moving the element connected with the shifter away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

27. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement; a spring rendered operative by longitudinal movement of the shifter for yieldingly urging the pinion toward the engine gear; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear, said connecting means permitting the shifter to move axially relative to the pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter; means responsive to the operation of the starting motor for automatically moving the element connected with the shift-

er away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

28. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the negine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, a normally compressed spring between the shifter and pinion for transmitting movement from the shifter longitudinally to the pinion for yieldingly urging the pinion against a gear of the engine to be started in case of tooth abutment; means limiting separation of the pinion from the shifter; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter; means responsive to the operation of the starting motor for automatically moving the element connected with the shifter away from the path of movement of the element connected with the actuator before the engine starts; and means for restoring the operative connection between these elements.

29. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; pinion shifting means constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifting means, the element operatively connected with the shifting means being mounted for limited rotation as well as movement axially of the pinion; means frictionally connecting said last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between the elements.

30. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; pinion shifting means constructed to urge the pinion against the gear with yielding pressure and to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifting means, the element operatively connected with the shifting means being mounted for limited rotation as well as movement axially of the pinion; means frictionally connecting said last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between the elements.

31. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially on the shaft and so connected with the shaft that axial movement is accompanied by rotary movement, and connected with the pinion to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter, the element operatively connected with the shifter being mounted for limited rotation as well as movement axially of the pinion; means frictionally connecting said last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between the elements.

32. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable axially along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary move-

ment; a spring rendered operative by longitudinal movement of the shifter for yieldingly urging the pinion toward the engine gear; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear, said connecting means permitting the shifter to move axially relative to the pinion; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter, the element operatively connected with the shifter being mounted for limited rotation as well as movement axially of the pinion; means frictionally connecting said last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between the elements.

33. Engine starting apparatus comprising, in combination, a motor; means for connecting the motor with a gear of an engine to be started and including a shaft, a pinion movable axially along the shaft into mesh with the engine gear, provisions whereby the pinion will be automatically demeshed from the gear when the engine starts, and a lost motion driving connection between the shaft and pinion; a pinion shifter movable along the shaft and having connection therewith whereby longitudinal movement along the shaft is accompanied by rotary movement, a normally compressed spring between the shifter and pinion for transmitting movement from the shifter longitudinally to the pinion for yieldingly urging the pinion against a gear of the engine to be started in case of tooth abutment; means limiting separation of the pinion from the shifter; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing with the engine gear; a manually operable actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and the pinion shifter, the element operatively connected with the shifter being mounted for limited rotation as well as movement axially of the pinion; means frictionally connecting said last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between the elements.

34. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; a pinion shifter constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and shifter; means responsive to the operation of the starting motor for automatically moving the element connected with the shifter away from the path of movement of the actuator element before the engine starts; and means for restoring the operative connections between these elements.

35. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; a pinion shifter constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and shifter, the element operatively connected with the shifter being supported by the shaft; means frictionally connecting the last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between these elements.

36. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; pinion shifter constructed to initially rotate the pinion prior to meshing and to take up lost motion between the shaft and pinion; a manually operated actuator; an element moved by the actuator longitudinally of the shaft; a device rotatably supported by the shaft and frictionally connected therewith and adapted to move the shifter endwise to mesh the pinion with the engine gear; an element provided by said device and normally in the path of movement of the actuator element but moved out of the path of movement of the actuator element when the motor operates; and a cam-element provided by said device and coacting with the actuator element to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the actuator element to effect the rotation of the device to normal position when the actuator is returned to normal position.

37. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; pinion shifter means constructed to initially rotate the pinion prior to meshing and to take up

lost motion between the shaft and pinion; a manually operated actuator; a pin element moved by the actuator along the shaft; and a cylindrical device rotatably supported by the shaft and frictionally connected therewith and movable against the shifter to move the pinion toward the engine gear, said device having a recess for receiving the pin and so shaped as to provide a surface normally located in the path of movement of the pin but moved out of the path of movement of the pin when the motor operates, and so shaped as to provide a surface oblique to the shaft and coacting with the pin to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the pin to effect the rotation of the device to normal position when the pin is returned to normal position.

38. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; means for shifting the pinion into mesh with the engine gear and operable in case of gear tooth abutment to apply pressure yieldingly between the pinion and engine gear while turning the pinion into meshing registration and taking up lost motion between the pinion and shaft; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and pinion shifting means; means responsive to the operation of the starting motor for automatically moving the element connected with the shifting means away from the path of movement of the actuator element before the engine starts; and means for restoring the operative connections between these elements.

39. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; means for shifting the pinion into mesh with the engine gear and operable in case of gear tooth abutment to apply pressure yieldingly between the pinion and engine gear while turning the pinion into meshing registration and taking up lost motion between the pinion and shaft; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and pinion shifting means, the element operatively connected with the shifting means being supported by the shaft; means frictionally connecting the last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between these elements.

40. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; means for shifting the pinion into mesh with the engine gear and operable in case of gear tooth abutment to apply pressure yieldingly between the pinion and engine gear while turning the pinion into meshing registration and taking up lost motion between the pinion and shaft; a manually operated actuator; an element moved by the actuator longitudinally of the shaft; a device rotatably supported by the shaft and frictionally connected therewith and adapted to move the pinion shifting means endwise to mesh the pinion with the engine gear; an element provided by said device and normally in the path of movement of the actuator element but moved out of the path of movement of the actuator element when the motor operates; and a cam-element provided by said device and coacting with the actuator element to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the actuator element to effect the rotation of the device to normal position when the actuator is returned to normal position.

41. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; means for shifting the pinion into mesh with the engine gear and operable in case of gear tooth abutment to apply pressure yieldingly between the pinion and engine gear while turning the pinion into meshing registration and taking up lost motion between the pinion and shaft; a manually operated actuator; a pin element moved by the actuator along the shaft; and a cylindrical device rotatably supported by the shaft and frictionally connected therewith and movable against the pinion shifting means to move the pinion toward the engine gear, said device having a recess for receiving the pin and so shaped as to provide a surface normally located in the path of movement of the pin but moved out of the path of movement of the pin when the motor operates, and so shaped as to provide a surface oblique to the shaft and coacting with the pin to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the pin to effect the rotation of the device to normal position when the pin is returned to normal position.

42. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; a pinion shifter mounted upon the shaft and helically splined thereto whereby longitudinal movement of the shifter effects rotation thereof; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and shifter; means responsive to the operation of the starting motor for automatically moving the element connected with the shifter away from the path of movement of the actuator element before the engine starts; and means for restoring the operative connections between these elements.

43. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; a pinion shifter mounted upon the shaft and helically splined thereto whereby longitudinal movement of the shifter effects rotation thereof; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and shifter, the element operatively connected with the shifter being supported by the shaft; means frictionally connecting the last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between these elements.

44. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; a pinion shifter mounted upon the shaft and helically splined thereto whereby longitudinal movement of the shifter effects rotation thereof; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing; a manually operated actuator; an element moved by the actuator longitudinally of the shaft; a device rotatably supported by the shaft and frictionally connected therewith and adapted to move the shifter endwise to mesh the pinion with the engine gear; an element provided by said device and normally in the path of movement of the actuator element but moved out of the path of movement of the actuator element when the motor operates; and a cam-element provided by said device and coacting with the actuator element to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the actuator element to effect the rotation of the device to normal position when the actuator is returned to normal position.

45. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft operated by the motor; a pinion having a lost motion driving connection with the helical splines and movable into mesh with a gear of an engine to be started; a pinion shifter mounted upon the shaft and helically splined thereto whereby longitudinal movement of the shifter effects rotation thereof; means connecting the shifter and pinion so that the pinion will be initially rotated to facilitate meshing; a manually operated actuator; a pin element moved by the actuator along the shaft; and a cylindrical device rotatably supported by the shaft and frictionally connected therewith and movable against the shifter to move the pinion toward the engine gear, said device having a recess for receiving the pin and so shaped as to provide a surface normally located in the path of movement of the pin but moved out of the path of movement of the pin when the motor operates, and so shaped as to provide a surface oblique to the shaft and coacting with the pin to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the pin to effect the rotation of the device to normal position when the pin is returned to normal position.

46. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft driven thereby; a pinion and a pinion shifter mounted upon said shaft and connected with said splines, the pinion having a lost motion driven connection with the shaft splines and movable into mesh with a gear of an engine to be started; a spring transmitting motion from the shifter to the pinion whereby the pinion will be yieldingly pressed against the gear in case of gear tooth abutment prior to meshing; means transmitting rotary movement from the shifter to the pinion; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and shifter; means responsive to the operation of the starting motor for automatically moving the element connected with the shifter away from the path of movement of the actuator element before the engine starts; and means for restoring the operative connections between these elements.

47. Engine starting apparatus comprising, in combination, a motor; a helically splined

shaft driven thereby; a pinion and a pinion shifter mounted upon said shaft and connected with said splines, the pinion having a lost motion driven connection with the shaft splines and movable into mesh with a gear of an engine to be started; a spring transmitting motion from the shifter to the pinion whereby the pinion will be yieldingly pressed against the gear in case of gear tooth abutment prior to meshing; means transmitting rotary movement from the shifter to the pinion; a manually operated actuator; disconnectible motion transmitting elements operatively connected respectively with the actuator and shifter, the element operatively connected with the shifter being supported by the shaft; means frictionally connecting the last mentioned element with the shaft whereby the element will be rotated away from the path of movement of the actuator element; and means for restoring the operative connection between these elements.

48. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft driven thereby; a pinion and a pinion shifter mounted upon said shaft and connected with said splines, the pinion having a lost motion driven connection with the shaft splines and movable into mesh with a gear of an engine to be started; a spring transmitting motion from the shifter to the pinion whereby the pinion will be yieldingly pressed against the gear in case of gear tooth abutment prior to meshing; means transmitting rotary movement from the shifter to the pinion; a manually operated actuator; an element moved by the actuator longitudinally of the shaft; a device rotatably supported by the shaft and frictionally connected therewith and adapted to move the shifter endwise to mesh the pinion with the engine gear; an element provided by said device and normally in the path of movement of the actuator element but moved out of the path of movement of the actuator element when the motor operates; and a cam-element provided by said device and coacting with the actuator element to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the actuator element to effect the rotation of the device to normal position when the actuator is returned to normal position.

49. Engine starting apparatus comprising, in combination, a motor; a helically splined shaft driven thereby; a pinion and a pinion shifter mounted upon said shaft and connected with said splines, the pinion having a lost motion driven connection with the shaft splines and movable into mesh with a gear of an engine to be started; a spring transmitting motion from the shifter to the pinion whereby the pinion will be yieldingly pressed against the gear in case of gear tooth abutment prior to meshing; means transmitting rotary movement from the shifter to the pinion; a manually operated actuator; a pin element moved by the actuator along the shaft; and a cylindrical device rotatably supported by the shaft and frictionally connected therewith and movable against the shifter to move the pinion toward the engine gear, said device having a recess for receiving the pin and so shaped as to provide a surface normally located in the path of movement of the pin but moved out of the path of movement of the pin when the motor operates, and so shaped as to provide a surface oblique to the shaft and coacting with the pin to cause the device to be retracted from the engine gear due to rotation of the device by the shaft when the motor operates, and also coacting with the pin to effect the rotation of the device to normal position when the pin is returned to normal position.

In testimony whereof I hereto affix my signature.

JOHN B. DYER.