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ENGINE STARTER DRIVE

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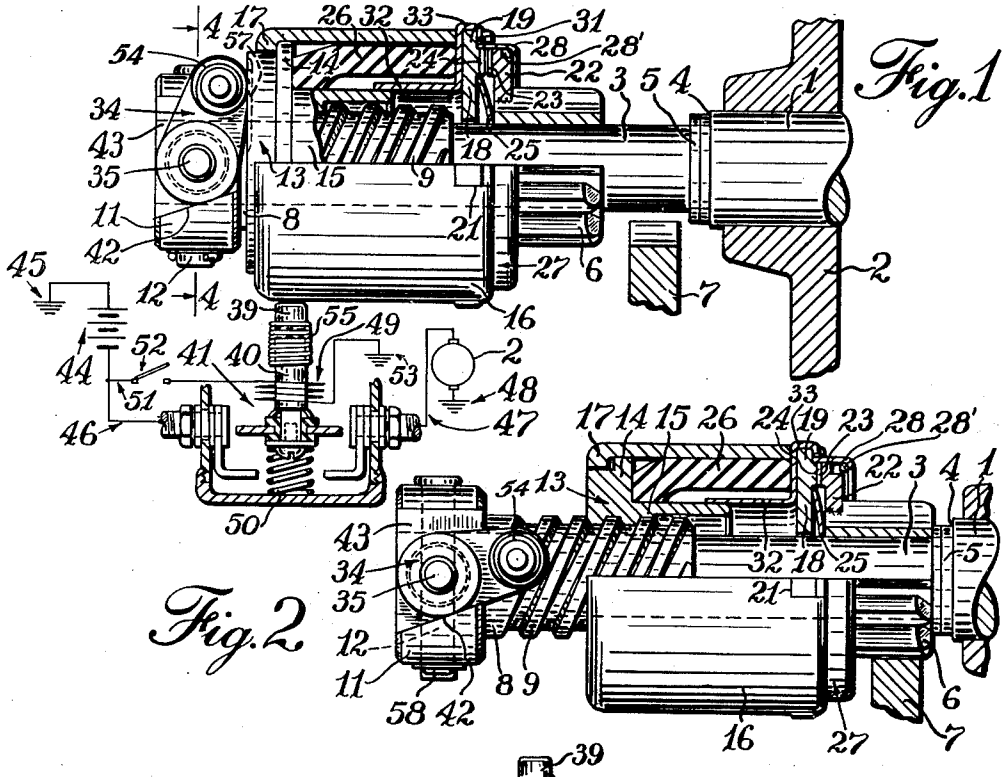


Fig. 1

Fig. 2

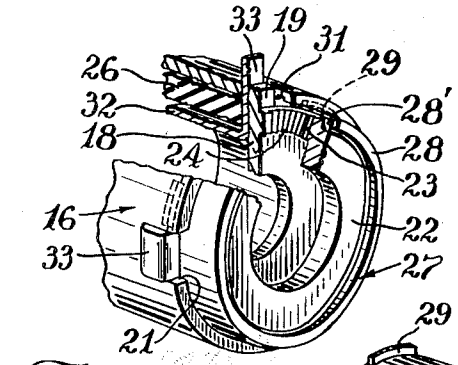


Fig. 3

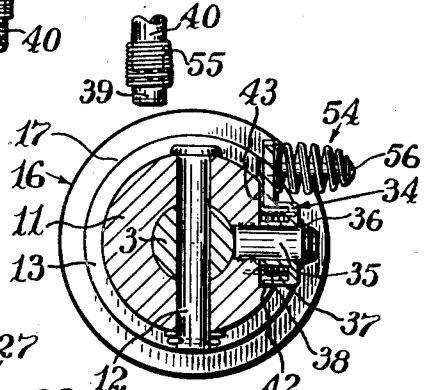


Fig. 4

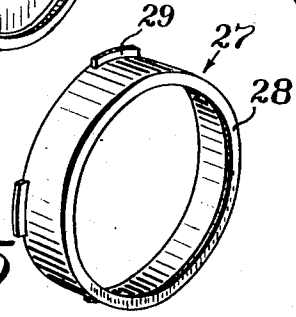


Fig. 5

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ENGINE STARTER DRIVE

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The present invention relates to an engine starter drive and more particularly to that type of starting drive in which a pinion is maintained in cranking engagement with a gear on the engine to be started as long as the starting circuit remains energized.

It is an object of the present invention to provide a novel engine starter of the above type embodying a starting circuit and in which a starter pinion is held in engagement with a gear on the engine to be started until the starting circuit is interrupted.

It is a further object to provide such a device, the parts of which are simple and economical to manufacture, easily accessible for servicing and repair and of durable construction.

It is a further object to provide such a device incorporating means for latching the pinion in mesh with the engine gear until self-operation of the engine is assured and means for unlatching the pinion responsive to the interruption of the starting circuit.

It is a further object to provide such a device embodying the use of a pivoted latch arm to oppose demeshing of the pinion from the engine gear during cranking of the engine and means responsive to the deenergization of the starting circuit for swinging the arm out of latching position.

It is a further object to provide such a device embodying the use of a pivoted latch arm to oppose demeshing of the pinion from the engine gear during cranking of the engine and means responsive to self-operation of the engine for swinging the arm out of latching position.

It is a further object to provide such a device including a latch arm for holding the pinion in mesh with an engine gear, and yielding means for urging the arm into latching position, said means being operative to oppose and progressively retard the demeshing movement of the pinion until idle position is reached so as to prevent rebounding of the pinion.

It is a further object to provide such a device having unitary means for maintaining the pinion in engagement with the engine gear during the starting operation and preventing the pinion from moving from disengaged position while the starter is idle.

It is a further object to provide such a device incorporating a movable latch arm and a cooperating intercepter therefor adapted to be projected into the path of rotation of the arm to control demesh of the drive pinion; and to further provide yielding elements on either or both

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of said members for cushioning the impact thereof as demeshing of the pinion occurs.

It is a further object to provide such a device including a clutch for rotating the pinion in association with latching means for maintaining the pinion in mesh with the engine gear during cranking, the clutch having novel structure for advantageous assembly and securing of its parts.

Further objects and advantages will be apparent to those skilled in the art from the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic representation of a starting system forming a preferred embodiment of the invention, the starting drive being shown in side elevation partly in section;

Fig. 2 is a view of the starter drive similar to Fig. 1 showing the parts in cranking position;

Fig. 3 is a representation in perspective of certain parts of the starting drive showing the novel locking mechanism used in assembling and securing the clutch;

Fig. 4 is a cross section of the starting drive on the line 4—4 of Fig. 1; and

Fig. 5 is a detail in perspective of the casing ring for the pinion clutch showing the lugs by which the casing is held in assembled position.

In Fig. 1 of the drawing, there is illustrated a power shaft 1 which may be the extended armature shaft of an electric motor 2, and is provided with a smooth extended portion 3 of reduced diameter providing a shoulder 4, against which thrust washers 5 are seated. A drive member in the form of a pinion 6 is journalled on the reduced extension 3 of shaft 1 in position to be traversed into and out of meshing engagement with an engine member such as a fly-wheel gear 7.

Means actuated by the motor 2 for moving the pinion 6 are provided including an operating member in the form of a screw shaft 8, provided with threads 9 and an enlarged head portion 11, fixed to the free end of the power shaft 1 in any suitable manner such as by an anchor pin 12. The pinion moving means also includes a control member in the form of a nut 13 threaded on the screw shaft and provided with an annular flange 14 and a smooth cylindrical extension 15 of reduced diameter.

Connecting means are provided between the nut 13 and pinion 6 comprising a barrel 16, having an inturned flange 17 on its outer end for enclosing flange 14 of the nut, and having an overrunning clutch connection with the pinion 6. As here shown, this clutch comprises a driving

clutch plate 18 fixed in the free end of the barrel by suitable means such as lugs 19 fitting within slots 21 in the barrel. A complementary clutch plate 22 is fixed to the pinion 6 by any suitable means such as welding or brazing and is preferably provided with teeth 23, adapted to engage with teeth 24 of the driving clutch plate. Means for normally separating the clutch plates 18 and 22 are provided in the form of a disc spring 25 bearing on one side against the pinion 6 and on the other side against the clutch plate 18. The connecting means between the control nut 13 and pinion 6 further includes a sleeve 26 of elastic material such as rubber, seated on the cylindrical portion 15 of the control nut and bearing frictionally at its ends against the flange 14 and driving clutch plate 18, so as to form a frictional driving connection therebetween.

Unitary means are provided for limiting the separation of the clutch plates 18 and 22, and locking the clutch plate 18 in position within the end of the barrel 16. As here shown, this means is in the form of a clutch housing ring or casing 27, having an inturned flange 28 and an inserted ring 28' adjacent the pinion forming an interior shoulder against which the clutch plate 22 rests. As best shown in Fig. 5, the casing 27 is also provided at its end adjacent the barrel with lugs 29 of a width slightly less than that of the slots 21 in the barrel, permitting the lugs to enter freely therein. An interior circumferential recess or groove 31 is formed in the end of the barrel 16, adapted to receive the lugs 29 of the clutch casing and thereby form a connection therewith in the nature of a bayonet joint. In order to lock the lugs 29 in the barrel, a thimble 32 is provided having a telescopic fit with the cylindrical extension 15 of the control nut for enclosing the rubber sleeve 26, and having tongues 33 extending radially through the slots 21 of the barrel. The tongues are bent over the lugs 19 of the clutch plate 18 to hold the clutch plate in the barrel, and the ends of the tongues are arranged to register with the groove 31 so as to lock the lugs 29 therein.

According to the present invention, means are provided for maintaining the pinion 6 in mesh with the engine gear 7 during the cranking operation in the form of a latch arm 34 pivoted on a radial pin 35 solidly fixed as by brazing in the head portion 11 of the screw shaft 8. The latch is retained on the pin by any suitable means such as a snap ring 36. As best illustrated in Fig. 4, the latch is provided with a hollow recess 37 on its underside in which is housed a spring 38 for biasing the arm 34 toward parallel relation with the axis of the motor shaft 1.

Means for releasing the latch responsive to the deenergization of the starting circuit are provided, comprising a trip member or intercepter 39. This member is preferably arranged as an extension or attachment to a solenoid plunger 40 forming part of a magnetic starting switch 41. Trip 39 is located adjacent the path of rotation of the free end of the latch 34 when the latch is swung into substantial alignment with the screw shaft as defined by a stop shoulder 42 formed by the termination of a flat surface 43 on the head 11. The shoulder 42 is preferably arranged to stop the latch before it comes into exact parallelism with the axis of the motor shaft. As shown in Fig. 2, this holds the latch out of a "dead center" relation to the nut 13, whereby the endwise pressure of the nut on the latch produces a component tending to rotate

the latch away from the shoulder 42. This position of the latch also causes the centrifugal force acting on the latch to have a small component tending to rotate the latch further out of parallelism with the shaft, since such rotation causes the center of gravity of the latch to move farther from the axis of the drive.

It is generally considered desirable to have a starter drive automatically disconnect itself when the engine is reliably self-operative even though the operator may neglect to open the starting circuit. In the present structure this may be accomplished by a proper location of the shoulder 42 whereby the rotary component of the pressure of nut 13 on the latch and/or the rotary component of centrifugal force may cause the latch to release when the engine and starting motor have attained such a speed that self-operation of the engine is assured. When the expression "substantial parallelism with the shaft" and similar expressions are used in the specification and claims, therefore, it is intended to refer not only to a possible condition of exact parallelism but also to include the condition in which the latch is maintained out of exact parallelism sufficiently to obtain the automatic demeshing operation above described.

The starting switch 41 is arranged to control a starting circuit for energizing the motor 2. As here shown, this circuit comprises a battery 44, grounded at 45 and connected by a lead 46 to the starting switch. A lead 47 connects the switch to the starting motor which is grounded at 48 to complete the circuit. Means under the control of the operator for actuating the switch plunger 40 are provided comprising a coil 49, one end of which is connected to the battery lead 46 by a lead 51 and manual switch 52, the other end being grounded at 53 to complete the control circuit. The plunger is normally held in position to open the switch 41 by suitable means such as a spring 50. The free end of latch 34 is provided with a radial projection or head 54 which is arranged to strike the trip 39 when the drive is rotating with the starting switch open, thereby swinging the latch away from the stop 42 and releasing the pinion. The impact of the projection against the trip is preferably cushioned by incorporating yielding or flexible means in either or both elements. Thus, the trip 39 may be connected to the plunger 40 by means of a coiled spring 55 suitably attached at its ends to said elements. Likewise, the projection 54 may be constructed as shown in Fig. 4 in the form of a spring member, the free end of which is attached to the latch by a rivet 56 in order to prevent expansion of the spring by centrifugal force.

The latch arm 34 is arranged to perform the further function of an anti-drift mechanism for normally maintaining the pinion member in its idle position. For this purpose a groove 57 is formed in the rear lateral face of the control nut 13 in position to receive the free end of the latch arm and form a seat therefor in which it is yieldably held by the pressure of spring 38.

In assembling the starting drive, the pinion with the driven clutch plate 22 thereon and the clutch housing ring 27 is slid over the power shaft 1 followed by the disc spring 25, driving clutch plate 18 and thimble 32. The latch sub-assembly is slid over the pin 35, first being sure that the outturned ends of the spring 38 are in place and retained by the snap ring 36. Then another sub-assembly is prepared by placing the

control nut 13 inside of the barrel 16 until it strikes flange 17 and placing the rubber block 26 inside the barrel against the flange 14 of the nut 13. Next, the pinion, clutch and thimble unit is assembled to the barrel. Said unit is then anchored to the barrel 16 by rotating the clutch casing 27 about 45 degrees so as to cause the lugs 29 thereof to enter the interior recess 31 of barrel 16 as best shown in Fig. 3. In order to prevent the casing 27 from becoming disengaged, the malleable tongues 33 of the thimble are then bent around the lugs 19 of plate 18 so that they enter the slots 21 and retain the lugs 29 in the groove 31. After all the tongues 33 have been bent over, this group of parts constitutes a subassembly bounded on one side by the pinion 6 and on the other by the control nut 13. The screw shaft 8 is then slid on the power shaft 1, threaded into the nut 13, and anchored on the power shaft by inserting the anchor pin 12 and locking it by a cotter key 58.

In operation, starting with the parts in the positions shown in Fig. 1, the manual switch 52 is closed by the operator to complete the control circuit and energize the coil 49 so as to close the starting switch 41 and simultaneously withdraw the trip 39 to clear the latch head 54. Upon closure of switch 41, the motor shaft 1 rapidly accelerates carrying with it the screw shaft 8 and the latch 34 mounted thereon. Due to inertia, the control nut 13 and its associated parts do not rotate, thus enabling the latch to move out of the anti-drift groove 57 and the control nut is traversed by threads 9 to the right in Fig. 1, carrying with it the barrel and pinion assembly. The traversal of the pinion is arrested by engagement with the thrust washers 5 at the moment of full mesh with the engine gear 7. Further traversal of the nut 13 then closes the clutch 18, 22 and compresses the rubber block 26 to complete the driving connection from the power shaft to the engine gear. While the control nut 13 is traversing along the screw shaft 8, the spring 38 swings the latch arm 34 into substantial axial alignment with the screw shaft against the stop shoulder 42, as shown in Fig. 2. When the engine starts, the pinion is accelerated by the engine gear faster than the starting motor, causing the control nut 13 to back away from the pinion and permitting the clutch dentals 23 and 24 to separate under the urging of spring 25. The latch arm 34 is spaced behind the control nut 13 far enough to allow the dentals to separate and permit the pinion to overrun freely, but further backward movement of the control nut is prevented, so that the pinion is held in mesh with the engine gear. If the engine does not continue self-operative, the cranking operation is therefore resumed as soon as the starting motor catches up with the speed of the engine gear.

When the engine becomes reliably self-operative, the operator opens the manual switch 52 thus opening the starting switch 41 and allowing the spring to move the trip 39 into the path of rotation of the projection 54 on latch 34. The latch is thus moved away from its locking position, permitting the pinion to demesh and the parts to return to idle position.

When the intercepting trip 39 moves into the path of the rapidly rotating latch 34, the severe blow struck is absorbed by the flexible head 54 and/or the flexible element 55 of the trip plunger. The demeshing shock occurring when the control nut is thrown back to idle position is controlled by the spring 38 which resists the pivotal movement of the latch arm 34 when contacted by the control nut 13. As the latch arm moves nearer to retracted position the resistance of the spring 38 progressively increases, thus retarding rotation of the control nut. When idle position of the control nut 13 is reached, the groove 57 on the rear face of the nut receives the end of the latch, thus opposing relative rotation between the screw shaft 8 and nut member 13, and constituting an anti-drift means for the pinion.

If, when the engine becomes self-operative, the operator fails to open the starting circuit, the starting motor will accelerate up to its "free spinning" speed. If the drive has been so designed that the shoulder 42 holds the latch at a suitable small angle to the plane passing through the axis of the shaft and the pivot of the latch as above described, the effect of centrifugal force, and/or the pressure of the nut 13 on the latch due to the dragging effect of the overrunning clutch member 22 as rotated at high speed by the engine will release the latch and allow the pinion to demesh from the engine gear. It has been found in practice that this angle is not at all critical, but angles between 5° and 10° have proved satisfactory for the purpose.

It will be understood that the effects due to the angular relation of the latch are present even when they are not sufficient in themselves to release the latch. They will therefore assist the action of the trip 39 to any desired extent, and by their concurrent action improve the operation of the device.

It will be seen that there is here provided a starting drive having novel features for securing the assembly of certain of its parts and having latching mechanism for maintaining the pinion in cranking engagement during the starting operation which is of simple design and readily accessible for servicing and adjustment.

Although but one embodiment of the invention has been shown, and described in detail, it will be understood that other embodiments are possible and changes can be made in the arrangement and proportions of the parts without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In an engine starter, a starting circuit including a motor and a starting switch, a starting drive operated by the motor having a driving member and means including an operating member and a control member actuated by the motor to move the driving member into and out of engagement with an engine member, a clutch between the control member and the driving member, means including a latch mounted on said operating member cooperating with said control member for maintaining the driving member in engaged position, a trip member, and means responsive to opening of the starting switch for moving the trip member into position to intercept and release the latch.

2. In an engine starter, a starting circuit including a motor and a starting switch, a starting drive operated by the motor having a driving member and means including an operating member and a control member actuated by the motor to move the driving member into and out of engagement with an engine member, an overrunning clutch between the control member and the driving member, means including a latch pivoted on said operating member for rotation around an axis radial thereto, and adapted to oppose disengagement of the driving member, a

trip member, and means responsive to opening of the starting switch for moving the trip member into position to intercept and release the latch.

3. In an engine starter, a starting circuit including a motor, a starting drive operated thereby having a pinion and means including a screw shaft and control nut actuated by the motor to move the pinion into and out of mesh with an engine gear to crank the engine, a clutch between the control nut and pinion, a latch arm pivoted on the screw shaft for rotation around an axis radial thereto and adapted to oppose demeshing of the pinion when swung into substantial parallelism with said shaft, a trip member, and means responsive to deenergization of the starting circuit for moving the trip member into position to intercept and release the latch arm.

4. In an engine starter, a starting circuit including a motor, a starting drive operated thereby having a pinion and means including a screw shaft and control nut actuated by the motor to move the pinion into and out of mesh with an engine gear to crank the engine, connecting means between said control nut and pinion including a clutch and a yielding member, said clutch being closed by the final meshing movement of the pinion, a radial pin in the screw shaft, a latch arm pivoted on the pin, arranged to extend toward the control nut during cranking of the engine and prevent premature demeshing of the pinion, said arm resisting backward rotation of the control nut on the screw shaft to decrease the demeshing shock of the pinion as it reaches idle position, and a trip member movable into the path of rotation of the latch when in extended position to release the latch concurrently with the deenergization of the starting motor.

5. In an engine starter, a starting circuit including a motor and a starting switch therefor, a starting drive operated by the motor having a pinion for traversal into cranking engagement with a gear on the engine to be started, and means including a screw shaft and a control nut threaded thereon for actuating said pinion, a radially pivoted latch arm mounted on the screw shaft to extend toward said control nut during cranking of the engine to prevent premature demeshing of said pinion, said control nut being formed to provide a seat adapted to receive the end of the latch when in idle position and thereby prevent drifting of said pinion out of idle position, and means dependent on the opening of the starting switch for returning the latch arm to idle position.

6. In an engine starter, a starting circuit including a motor and a starting switch therefor, a starting drive operated by the motor having a pinion for traversal into cranking engagement with a gear on the engine to be started; means for actuating the pinion including a screw shaft, a control nut threaded thereon, a thimble bearing on said control nut, a barrel and an overrunning clutch connecting the barrel to the pinion; a clutch housing swiveled to said barrel, said thimble having radial extensions for locking the clutch housing in assembled position, a latch movable in a plane parallel to the axis of the shaft to maintain the pinion in mesh during cranking of the engine, and means dependent on the opening of the starting switch for unlatching the pinion.

7. In an engine starter, a starting circuit including a motor and a starting switch therefor,

a starting drive operated by the motor having a pinion for traversal into cranking engagement with a gear on the engine to be started, and means including a screw shaft and a control nut threaded thereon for actuating said pinion, a latch arm mounted on the screw shaft for pivotal movement in a plane parallel to the axis of the screw shaft and biased into extended position to prevent premature demeshing of the pinion during cranking of the engine and an intercepter member actuated by the opening of the starting switch for engaging said arm to unlatch the pinion.

8. In an engine starter, a starting circuit including a motor, a starting drive operated thereby having a pinion and means including a screw shaft actuated by the motor, a control nut threaded thereon and an overrunning clutch operative to traverse said pinion into and out of mesh with an engine gear and rotate the pinion to crank the engine, said screw shaft having a drive head providing a flat surface terminating in an erect shoulder, a latch arm movable on said surface into latching position as defined by said shoulder to hold the pinion in meshed position during the starting operation, a yielding head on the latch arm, and means responsive to deenergization of the starting circuit for contacting said yielding head to move the arm away from latching position.

9. In an engine starter, a starting circuit including a motor and a starting switch therefor, a starter drive operated by said motor having a pinion adapted to move into and out of engagement and rotate a gear on the engine to be started and means for actuating said pinion including a screw shaft; a pin mounted radially on said screw shaft, means including a latch pivoted on said pin for maintaining the pinion in mesh with the engine gear during cranking, and a trip member actuated by said starting switch, said trip having a flexible tip thereon adapted to engage the latch to release the pinion.

10. In an engine starter, a power shaft, a pinion journalled thereon for longitudinal movement into and out of mesh with an engine gear, means for traversing and rotating the pinion from the power shaft, means for holding the pinion in mesh with the engine gear, electromagnetic means for releasing the holding means, manually controlled means for actuating the electromagnetic means and means for releasing the holding means irrespective of the manual means and adapted to operate concurrently to assist the manual means.

11. In an engine starter, a power shaft, a pinion journalled thereon for longitudinal movement into and out of mesh with an engine gear, means for traversing and rotating the pinion from the power shaft, means including a pivoted arm for holding the pinion in mesh with the engine gear, means for stopping the pivotal movement of the arm at a small angle to the axis of the shaft, and electromagnetically actuated means for engaging and swinging the arm away from said stopping means, and manually controlled means for actuating the electromagnetic means.

12. In an engine starter, a power shaft, a pinion movable longitudinally thereon into and out of mesh with an engine gear, means actuated by the shaft for moving the pinion into mesh with the engine gear, and then rotating the pinion, means on the power shaft for holding the pinion in mesh with the engine gear, said means being movable by centrifugal force to release the pinion at a predetermined rotational speed, and means re-

sponsive to deenergization of the starter for moving the holding means to release the pinion.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,218,972	Kearney	Oct. 22, 1940
2,287,669	Buxton	June 23, 1942
2,332,986	Buxton	Oct. 26, 1943
2,339,486	Kearney	Jan. 18, 1944