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STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED DEC. 9, 1918.

1,414,233. **Patented Apr. 25, 1922.**

3 SHEETS—SHEET 1.

Fig. 1.

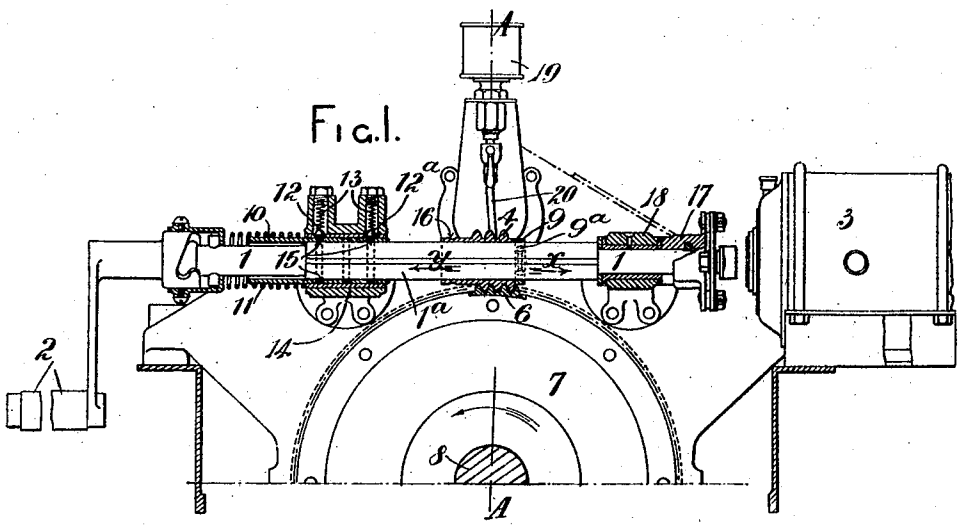


Fig. 2.

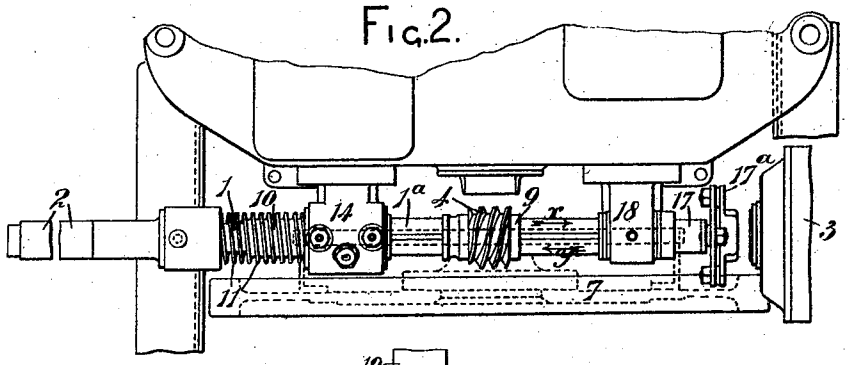
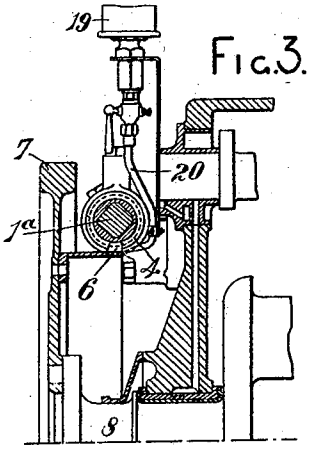


Fig. 3.



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3 SHEETS—SHEET 2.

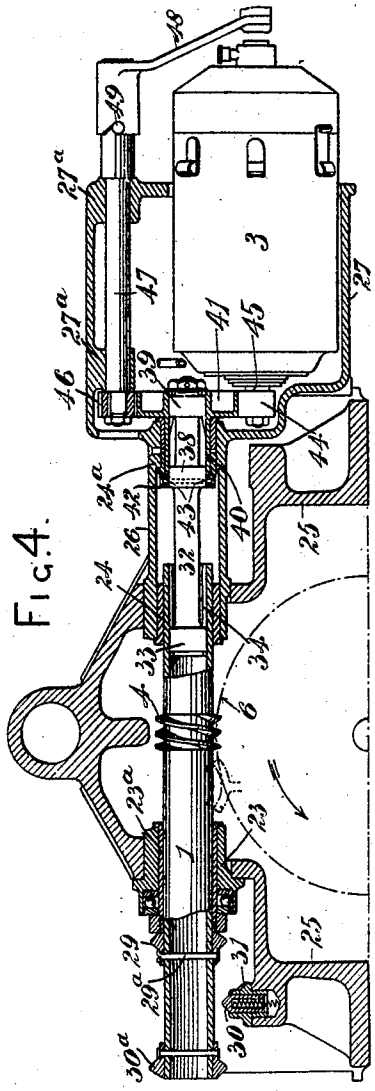


FIG. 4.

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3 SHEETS—SHEET 3.

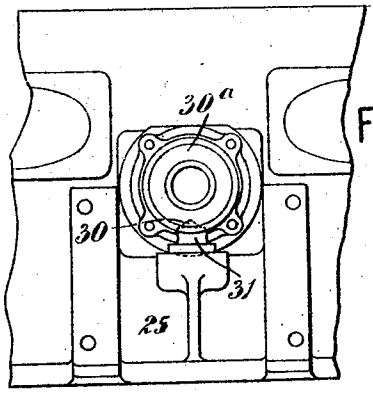


Fig. 5.

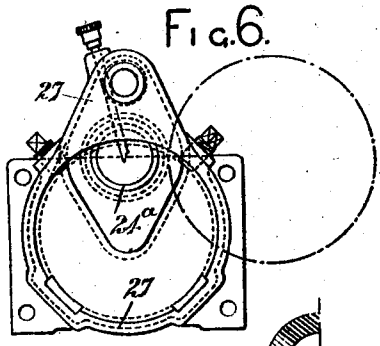


Fig. 6.

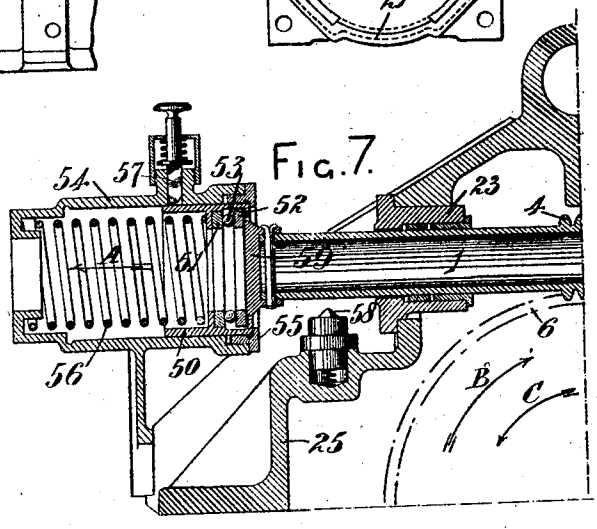


Fig. 7.

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UNITED STATES PATENT OFFICE.

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STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES.

1,414,283. Specification of Letters Patent. Patented Apr. 25, 1922.

Application filed December 9, 1918. Serial No. 265,918.

To all whom it may concern:

Be it known that I, ISAAC THOMAS THORNYCROFT, (usually known as TOM THORNYCROFT,) a subject of the King of Great Britain and Ireland, residing at the city of Westminster, England, have invented Improvements in or Relating to Starting Mechanism for Internal-Combustion Engines, of which the following is a specification.

This invention has reference to starting mechanism for internal combustion engines wherein the power shaft of the starting mechanism is automatically disconnected from the engine shaft when the engine starts running in a forward direction and also when, in the event of back firing, or pre-ignition, the engine is caused to run in a backward direction.

The present invention has reference to improved constructions of engine starting apparatus of the type referred to, as will now be described with the aid of the accompanying illustrative drawings.

In these drawings, Fig. 1 shows partly in elevation and partly in longitudinal section, and Fig. 2 in plan, and more or less diagrammatically, one construction of engine starting mechanism according to the invention. Fig. 3 is a cross section on the line A A of Fig. 1.

Fig. 4 illustrates a similar view to Fig. 1, showing another construction of the mechanism. Figs. 5 and 6 are detail views illustrating in end view, from opposite directions, the crank case and the starter bracket respectively of the mechanism shown in Fig. 1. Fig. 7 shows, in longitudinal section, part of a further modified construction.

According to the example shown in Figs. 1, 2 and 3, the power shaft 1 of the starting mechanism carries at one end a crank handle 2 which, as usual, is movable endwise thereon so as in this way to become engaged therewith. The other end of the shaft is connected to the electric starting motor 3. Intermediately of its length, the power shaft 1 carries a worm 4 that is adapted to slide endways on a square or splined portion 1^a of the said shaft, and which, in one position, namely that illustrated, herein called its forward position, engages with a worm wheel 6 secured, as by bolting to the fly wheel 7 of the engine, or otherwise fixed to the engine crank shaft 8. The worm 4 is thus movable tangentially to the worm wheel 6. The sliding of the worm 4 in the forward direction, shown by the arrow x, from its engaged position, is prevented by an abutment which, in the example, is shown in the form of a collar 9 connected by a pin 9^a to the shaft 1. When the shaft is moved in the opposite or backward direction, shown by the arrow y, owing to the engine taking up the driving of the fly wheel 7, the worm 4 will move out of gear with the worm wheel 6. In its backward movement, the worm abuts against and moves endwise along the power shaft 1, a sleeve 10 that extends towards the crank handle 2. This sleeve 10 is adapted to be moved in the other or forward direction along the shaft 1 by the forward end ways movement of the hollow boss of the crank handle 2 along the shaft 1, it may be against the action of a coiled spring 11 surrounding the power shaft 1, so as to force the worm 4 with it into contact with the worm wheel 6 when it is desired to start the engine. To enable this to be done the boss of the handle is so formed internally that when partly turned into one position it can be moved forward past the lug on the shaft with which the said boss is adapted to engage when the latter is afterwards moved backward and partly rotated into another position. Rotation of the power shaft 1 by the motor 3, or by the crank handle 2, will then cause the worm 4 to gear with the worm wheel 6 and to travel into contact with the collar 9 before starting or commencing to turn the worm wheel for starting the engine.

Balls 12 and 12^a, subject to the pressure of springs 13 and mounted in a stationary bearing 14 for the power shaft 1 and sleeve 10, are adapted to engage external grooves 15 in the sleeve and thus to hold the latter in either its extreme backward or forward position, one of the said balls, namely the ball 12^a also serving, by engagement with a groove 16 in the boss of the worm, to hold the latter in its disconnected backward position clear of the wheel 6. If the engine runs backward when being started up, the pin 9^a holding the collar 9 to the power shaft 1, will be sheared and the worm 4 will then be thrown in a forward direction along the shaft 1 out of gear with the wheel 6 and damage will thus be avoided. A new pin 9^a can easily be afterwards fitted to enable the mechanism to be used again. A flanged ring 17 fixed to the power shaft 1 serves, in conjunction with a bearing 18, to hold the power

shaft in an endwise direction. The flanged ring 17 also serves to connect the power shaft 1 to a flange 17ª connected to the rotor of the electric motor 3 which may be arranged coaxially therewith. Means, such as a receptacle 19 and duct 20, are or may be provided for supplying lubricant to the teeth of the worm wheel 6.

In the example illustrated in Figs. 4, 5 and 6, the worm 4 is fixed to or formed on a hollow horizontal power shaft 1 mounted to slide endways in stationary bearings 23, 24 carried by a frame or support 25. This frame or support also carries, at one end, a tubular extension 26 of a bracket or casting 27 for an electric motor 3 which is also arranged with its axis horizontal. To the left hand end portion of the power shaft 1 is fixed a ring 29, of V shape in section, adapted to coact with a spring controlled holding device or detent 30 of similar shape in section carried in a holder 31 fixed to the frame or support 25. The detent 30 is adapted, when the power shaft 1 with its worm 4 is moved into its backward or left hand inoperative position, to yield in a downward direction to admit of the passage of the ring 29 on the shaft and then to return and retain the shaft in its inoperative position.

In this example the ring 29 serves as the safety or yielding device for holding the hollow power shaft 1 and worm 4 in the intermediate and operative position and to yield and allow the shaft and worm to be moved into the forward inoperative position by the worm wheel 6 when this wheel is driven in a backward direction by back firing or pre-ignition. For this purpose the ring 29 is adapted to bear against the outer end of a bush 23ª held endways in the bearing 23, and is connected to the power shaft 1 by a pin 29ª that will be sheared when the shaft and worm are forced forward by backward rotation of the worm wheel 6.

Into the forward end portion of the hollow power shaft 1 extends the rearward end of a secondary power shaft 32, the two shafts 1 and 32 being in driving connection with each other by means, such as a head 33 on the secondary shaft 32 taking into longitudinal grooves 34 in the hollow shaft 1, so that the hollow power shaft can slide endways over the secondary shaft 32 and be rotated by the latter shaft. The forward end of the secondary shaft 32 is provided with two cylindrical enlargements 38 and 39 that are spaced apart as shown and are arranged to extend into the hollow lateral boss 40 of a toothed driving wheel 41. The hollow boss is mounted to rotate in a forward bearing 24ª carried by the tubular extension 26 and is held endwise in such bearing by the toothed driving wheel 41 bearing against the forward end of the said bearing and by a ring 42 that bears against the rear or opposite end of the bearing and is fitted to the secondary shaft 32 by a pin 43 that passes transversely through it and the rear cylindrical enlargements 38 of the secondary shaft. The toothed driving wheel 41 is in gear with a toothed pinion 44 on the driving shaft 45 of the electric motor 3 and with a toothed pinion 46 fixed to one end of a shaft 47 the outer end of which carries a crank handle adapted to drive such shaft in one direction only, in the usual way, through a pin 49 on the shaft. The shaft 47 is arranged horizontally and carried in bearings 27ª in the bracket or casing 27 carrying the electric motor 3. In this arrangement the hollow power shaft 1 is adapted to be moved forward by hand or otherwise to bring the worm 4 thereon against the worm wheel 6, and to be rotated by hand by the crank handle 48, or by the electric motor 3, to bring the worm 4 into gear with the worm wheel 6 and the safety ring 29 against the bush 23ª to then enable the worm and worm wheel to be rotated by hand, or by the electric motor 3, to start the engine. When the engine commences to run in a forward direction on its own account, the worm 4 and shaft 1 will be moved backward into the out of gear or inoperative position by the worm wheel, in which position they will be held by the spring controlled detent 30 engaging the forward side of the safety ring 29. Should the engine run in a backward direction, the worm 4 and shaft 1 will be forced forward by the worm wheel 6, thereby shearing the safety pin 29ª and finally assuming an out of gear or inoperative position in which they will be retained by the engagement of the rear side of a ring 30ª on one end of the shaft 1 with the spring controlled detent 30.

Fig. 7 shows an arrangement in which the safety device is constituted by a spring controlled abutment device. In the example shown, this abutment device comprises a piston 50 carrying a ball thrust device consisting of two rings 51 and 52 with interposed anti-friction balls 53. The piston with ball thrust device is arranged to slide in a cylinder 54 rigidly fixed to the framework 25. The piston with ball thrust device is normally held in the position shown against a rigid annular screw stop 55 by a coiled spring 56. To the adjacent end of the shaft 1 is fixed a cap or disc 59 that is independent of the piston 50 and of the ring 52 against which it normally bears. The spring 56 is sufficiently compressed to ensure that the piston with ball thrust device shall act as a rigid abutment for the shaft 1 through its cap or disc 59 so long as the thrust of the shaft in the direction of the arrow A does not exceed the normal amount required to turn the worm wheel 6 in the normal direction, shown by the arrow B, to turn the engine for starting in the normal running direction. But in the event of the

thrust of the shaft in the direction A attaining an abnormal value, due to a back fire or other cause, tending to turn the engine in a direction contrary to the normal rotation and thereby to turn the worm wheel 6 in the direction of the arrow C, then the spring 56 will become further compressed and allow the worm 4 to move out of disengagement with the worm wheel 6. A spring detent 57 serves, automatically, to prevent the return of the piston 50 with ball thrust device 51—52—53, under the action of the spring 56, until such time as it may be released by withdrawing the detent by hand. 58 is another spring controlled detent adapted to engage with the cap 59 fixed to the adjacent end of the shaft 1, to prevent the re-engagement of the worm 4 with the worm wheel 6 after the shaft 1 has been pushed to the right by the rotation of the worm wheel, when the engine has been started in the required normal direction of running. In other respects, as for example the means adopted to rotate the shaft 1 by electrical or manual power, the apparatus may be constructed as in Figs. 4, 5 and 6. In Fig. 7, the normal direction of turning of the worm wheel 6 is shown as the reverse of that indicated, in Figs. 1 and 4.

What I claim is:—

1. Engine starting mechanism comprising a worm wheel for connection to the driving shaft of an engine, a power shaft tangential to said worm wheel, bearings for said shaft, a worm carried by said power shaft and adapted to be moved into a forward operative position in gear with said worm wheel, into a backward inoperative position and also into a forward inoperative position, a rigid stop device connected to said shaft by a shear pin and serving normally to hold said worm in its forward operative position but capable of yielding by shearing the pin, to allow of said worm moving into its forward inoperative position when moved in a forward direction by said worm wheel rotating in a backward direction, and means for rotating said shaft.

2. For starting an internal combustion engine, mechanism comprising a worm wheel for connection to an engine shaft, an endways movable power shaft arranged tangentially to said worm wheel, a worm fast on said power shaft, bearings in which said power shaft can slide endways to move said worm into a backward inoperative position, into an intermediate position to bring said worm into operative connection with said worm wheel and into a forward position to admit of said worm occupying a forward inoperative position, means arranged external to one of said bearings and adapted normally to hold said power shaft in its intermediate position but capable of yielding when subjected to undue pressure and of then permitting said shaft and worm to move into the forward inoperative position and means for rotating said power shaft and worm.

3. For starting an internal combustion engine, a worm wheel for connection to an engine shaft, an endways movable power shaft arranged tangentially to said worm wheel, a worm fast on said shaft, bearings at opposite sides of said worm in which said shaft can slide endways to move said worm into a backward inoperative position, into an intermediate position to bring said worm into operative connection with said worm wheel and into a forward position to admit of said worm occupying a forward inoperative position, means arranged external to one of said bearings adapted normally to hold said power shaft in its intermediate position but capable of yielding when subjected to undue pressure and of then permitting said shaft and worm to move into the forward inoperative position, a secondary power shaft co-axial with and in driving connection with said power shaft, said power shaft being capable of endways motion independently of said secondary shaft, and a driving means arranged to rotate said secondary shaft and thereby said power shaft and worm.

4. Engine starting mechanism according to claim 3, wherein the means for normally holding the power shaft in its intermediate and operative position and for permitting it to be moved into its forward operative position by backward rotation of the worm wheel comprises a ring connected to the shaft by a shaft pin and arranged to bear against a fixed abutment when the shaft and worm are in the said intermediate and operative position but to yield when the shaft and worm are urged forward from that position by backward rotation of the worm wheel.

5. Engine starting mechanism according to claim 3, wherein there is combined with the driving means, a toothed driving wheel driven from the said driving means and provided with a hollow lateral boss into which the secondary driving shaft extends, said wheel being in driving connection with the driving shaft of said driving means.

6. Engine starting mechanism according to claim 3, embodying a toothed driving wheel having a hollow lateral boss, wherein said boss is mounted to rotate in a stationary bearing and is prevented from moving axially therein in one direction by the said wheel which is arranged to bear against one end of the bearing, and from moving in the opposite direction by a ring fixed to the secondary driving shaft and bearing against the opposite end of the said bearing.

7. Engine starting mechanism according to claim 3, wherein there is associated with the secondary shaft and the motor, a toothed wheel driven by said driving means and con-

nected to said secondary shaft, a fixed casing or support provided with bearings, a hand operated shaft mounted in said bearings with its axis parallel to the axis of the driving means and a toothed wheel fixed to said hand operated shaft and in gear with the toothed wheel driven by said driving means.

8. Engine starting mechanism, comprising a worm wheel for connection to the driving shaft of an internal combustion engine, an endways movable power shaft with worm adapted to be moved by endways motion of said shaft into and out of gear with said worm wheel, bearings for said power shaft arranged at opposite sides of said worm, a ring connected to said shaft by a yielding device and adapted to bear against the outer side of one of said bearings when the worm is in its operative position, a secondary shaft coaxial with the power shaft and in driving connection with such shaft, a driving wheel fixed to said secondary shaft, a bearing for said driving wheel, a driving mechanism in gear with said driving wheel and a hand operated gear wheel also in gear with said driving wheel.

Signed at London, England, this thirteenth day of November, 1918.

TOM THORNYCROFT.