

Feb. 27, 1934.

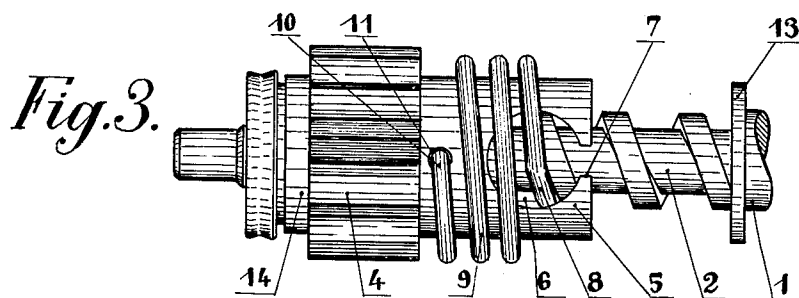
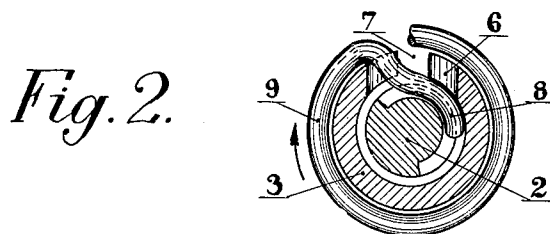
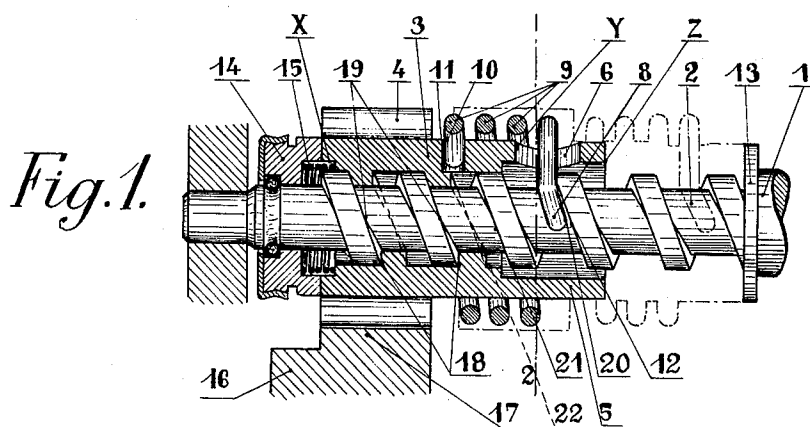
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1,948,897

STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed March 31, 1932

2 Sheets-Sheet 1



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# STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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2 Sheets-Sheet 2

*Fig.4.*

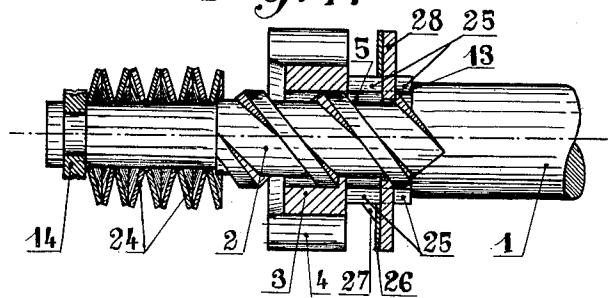


*Fig. 5.*

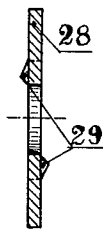


*Fig. 6.*

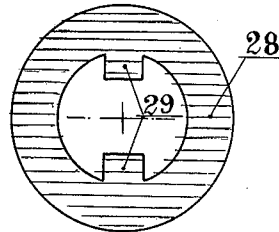


*Fig. 7.*

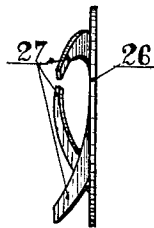
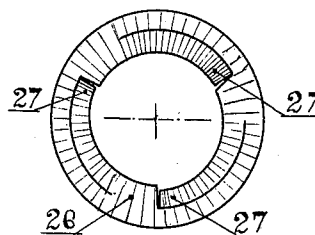


*Fig. 8.*



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## UNITED STATES PATENT OFFICE

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STARTING DEVICE FOR INTERNAL  
COMBUSTION ENGINES

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Application March 31, 1932, Serial No. 602,297

In France April 11, 1931

5 Claims. (Cl. 74-7)

This invention relates to starting devices for internal combustion engines, and particularly to devices having automatic means for positively connecting the starter to the engine to be started.

5 The invention utilizes in a novel construction a conventional type of pinion forming a nut which rides on a screw shaft. Said pinion is moved by inertia at the time the starter is set in motion and is adapted to mesh with a gear-wheel carried by the engine to be started.

10 Apparatus of this type to be practical must overcome the difficulty which arises when the end of the tooth of the pinion comes in contact with the end of the teeth of the gear wheel of the engine. It is essential to avoid any wedging that the pinion, the rotation of which has been stopped, may be permitted to have an angular and longitudinal movement along the shaft of the starter so as to turn relative to the end of the tooth with which it is in contact and then to move for properly meshing with the gear-wheel of the engine.

Usually this difficulty is overcome by interposing a strong heavy spring between the pinion and the shaft of the starter. Such spring transmits either the entire torque generated by the starter or a resultant thereof. Such spring therefore withstands considerable stresses, particularly, when the engine recoils due to premature ignition. In such cases the springs are often permanently distorted and broken. Such springs to be practical must therefore be relatively large, heavy and cumbersome, and costly to manufacture. They also require the use of numerous other parts for assembly which are also cumbersome and expensive.

The invention will be seen to comprise an improved device of the character described having a starter shaft formed with a thread of long pitch. This thread includes a space between its turns, that is to say, the turns are not tangent as in a normal thread, but are spaced apart so as to leave between them a free portion or zone.

Said improved device also has a pinion formed with a tail piece and constitutes a nut which rides on the starter shaft thread. The thread of the pinion nut has substantially the same pitch as the thread of the starter shaft on which it is mounted.

50 Said improved device in addition provides said pinion with a resilient member having one end pressing on the thread of the starter shaft and the other or opposite end bearing on the pinion. This resilient member is so proportioned and positioned relative the pinion and the starter shaft

that when the device is at rest said member takes up substantially all the longitudinal play or clearance and also all the angular play or clearance existing between the pinion and the starter shaft due to the formation of the threads on the pinion nut and starter shaft as described above.

The invention will be clearly understood from the following description and drawings in which is shown various possible illustrative embodiments of the invention given by way of example only. With reference to the accompanying drawings:

Fig. 1 is a longitudinal sectional view of a device embodying the invention.

Fig. 2 is a cross-sectional view taken on line 2-2 in Fig. 1.

Fig. 3 is a plan view corresponding to Fig. 1.

Fig. 4 is a longitudinal sectional view of a modified form of device embodying the invention.

Figs. 5 and 6 are side and elevational views, respectively, of a bearing washer forming part of the device shown in Fig. 4, and

Figs. 7 and 8 are side and elevational views, respectively, of a resilient washer forming part of the device shown in Fig. 4.

Referring now to the drawings, in Figs. 1 to 3, an improved starting device of the character described is shown, said device being adapted to automatically make a positive temporary connection between a starter and internal combustion engine.

The parts or elements are preferably made, fitted in position and arranged as follows:

A shaft 1 of a starter rotor which is mounted for providing starting power for an internal combustion engine, carries at one of its ends an integrally formed screw-threaded part 2, said thread having a relatively long pitch for the purpose hereinafter described. A nut 3, comprising a tooth pinion 4 and an extending tail piece 5 is mounted on said screw-threaded part 2 of said starter shaft. The tail piece 5 of said nut is formed with a hole 6 communicating with a slot 7. Into said hole 6 extends one end 8 of a spring 9, the latter being wound about the tail piece 5 of the pinion nut and is secured to the latter by the other or opposite end 10. Said end 10 extends into a hole 11 provided in said tail piece 5, as is clearly shown in Figs. 1 and 3. The end 8 of the spring is curved so as to closely fit the flank 12 of the starter shaft thread, as is clearly shown in Fig. 2. The spring 9 when positioned in place may be slightly stretched by winding it about the tail piece 5 of the nut 3 to permit the end 10 of said spring to enter into the hole 11 while the other end 8 is inserted

in the hole 6. The slot 7 communicating with the hole 6 serves to place the spring 9 in position and to allow passage of the curved end 8 of the spring, thus facilitating the assemblage of the latter. For limiting the movement of the pinion nut on the starter shaft, the ends of the screw-shaft may be provided with spaced abutment stops 13 and 14.

A light coil spring 15, interposed between the end of the pinion nut and the abutment 14, retains the pinion nut in its normal position of rest, as shown in dotted lines in Fig. 1.

The fragmentary part of a fly-wheel of the engine to be started is shown at 16 in Fig. 1, said fly-wheel having a gear-wheel 17 adapted to engage with the pinion 4.

As described above, the pinion 4 and the integrally formed tail piece 5 constitutes the nut 3 which is normally retracted and not in mesh with the gear-wheel 17, as indicated in the dotted line in Fig. 1 of the drawings. The light spring 15 tends to hold said nut in this position spaced from the abutment 14. The respective positions of the pinion nut 3, screw shaft 2 and spring 9 are then such that the flank 18 of the internal screw thread of said nut 3 is brought in close proximity to the flank 19 of the starter shaft thread. In fact this position is positively attained by the location of the end 8 of the powerful spring 9, said end being tangent at 20 to the flank of the threads 12 of the starter shaft.

It is to be noted that the internal screw-thread of nut 3 extends only through the portion XY thereof, the portion YZ being of smooth bore and therefore without any screw-threads as shown in Fig. 1.

The operation of an improved device such as described above is as follows:

Assuming the internal combustion engine to be at rest and as described above the pinion nut in its normal position of rest as indicated in dotted lines in Fig. 1, the starter (an electric starter being here considered) is connected to a suitable power source which causes the starter shaft to rotate in the direction indicated by the arrow shown in Fig. 2. Due to inertia the pinion nut advances on the starter shaft thread from its retracted position shown in the dotted line in Fig. 1 in the direction of the fly-wheel of the engine by being pushed, since the end 8 of the spring 9 is caused to advance along the shaft-thread 12.

If, in the course of this movement of translation of the pinion 4 toward the abutment stop 14 the ends of the pinion teeth do not come into contact with the ends of the teeth of the gear-wheel 17, the pinion 4 will enter into proper mesh engagement with said gear-wheel 17 and will abut against the abutment stop 14. The light spring 15 will then be fully compressed and as the pinion nut 3 can no longer continue in its longitudinal movement of translation, said nut will be caused to rotate by the starter shaft in the following manner.

When the pinion nut 3 is stopped by the abutment stop 14, the pinion 4 being then in mesh engagement with the gear-wheel 17, the resistant torque of the engine to be started tends to prevent the pinion nut from rotating. The end 8 of the compression spring 9 is then carried along by the thread 12 of the shaft. The movement of said spring end 8 is only opposed by the resiliency of the spring 9 which is readily overcome by the starter torque generated.

The starter shaft therefore rotates (without

the pinion which is then held stationary) a sufficient distance to bring the edge 21 of the shaft thread in contact with the edge 22 of the inner screw-thread of the pinion nut. During this slight rotation of the starter shaft relative to the nut, the spring 9 is compressed and is wound up an amount corresponding to the relative displacement of the starter shaft with respect to the pinion nut. As soon as the screw-thread edges 21 and 22 come in contact the pinion 4 will be caused to rotate with the starter shaft through the gear-wheel 17 for driving the engine. It is to be noted that the torque then generated by the starter is directly transmitted to the pinion by the starter shaft without the intermediary compression spring 9. In fact, the spring 9 is only subjected to a relatively small torque compared with the total torque required for starting the engine. This small torque exerted on the spring 9, due to the angular displacement of the starter shaft relative to the pinion nut, provides a positive drive for the latter by eliminating (in the direction of rotation) the play or clearance existing between the respective external and internal threads of the starter shaft and nut.

When the internal combustion engine has been started and the peripheral speed of the gear-wheel 17 becomes greater than the corresponding maximum peripheral speed of the pinion driven by the starter, the pinion nut unscrews on the starter shaft. On releasing the spring 9 from its compression, the pinion will come back to its normal position of rest indicated in dotted lines in Fig. 1. Here said pinion nut will be held by the small spring 15.

Returning now to the starting operation above described, if it is assumed that when the forward or leading end of the pinion 4 is advanced from its retracted position toward the gear-wheel 17 and said leading pinion end engages with the end of the gear-wheel preventing the proper mesh engagement, the following takes place:

As the pinion is stopped by the teeth of the pinion and the gear-wheel coming into abutment, the movement of translation of the pinion nut is necessarily stopped and the latter can no longer move forward of its projected position. The starter shaft will however continue to rotate against the compressive action of the spring 9, owing to the play or clearance existing between the shaft-threads and those of the pinion. When thus rotated, said shaft drives through its thread the spring end 8 and compresses and winds up the spring 9 causing it to exert by reaction a tangential and axial resilient stress, that is, turning force on the pinion nut 3. This is accomplished because the spring 9 has its end 10 opposite the end 8 secured in the hole 11 of the pinion. When the tangential stress or turning force due to the progressive tension of the spring 9 becomes sufficiently great to overcome the resistance opposing sliding movement of the tooth of the pinion against the tooth of the gear-wheel with which it is in engagement, the pinion nut will rotate (being urged by the spring 9) a sufficient amount for sliding the end of the pinion tooth on the gear-tooth until there is no further obstruction to the forward or projecting movement of the pinion nut. The pinion is pushed forward by the compressive force of the spring 9 when it comes into the normal position to permit meshing engagement between the pinion 4 and the gear-wheel 17. The spring 9 then is released, the pinion 4 and gear-wheel 17 become properly

meshed, and the starting operation of the engine continued as described above.

In Figs. 4 to 8 of the drawings, there is shown second form of construction of starting device 5 embodying the invention. The latter here shown, provides a less cumbersome, lighter and relatively less expensive construction than the first starting devices described above and shown in Figs. 1 to 3, inclusive. In this second form of 10 starting device, the coil compression spring 9 which has the double function of providing a resilient element and a spacing element bearing on the shaft thread 2 used in the first form as shown in Figs. 1 and 2 is replaced by resilient 15 means acting solely through its resiliency and by a separate guide means bearing on the flanks and starter-shaft thread.

This second form of starting device is also adapted to form an automatic means for positively 20 connecting the starter to an internal combustion engine and is constructed similar to the first form of device except as will hereinafter be pointed out.

The shaft 1 of the starter rotor carries on one 25 of its ends the integrally formed screw-thread part 2 having a long pitch. A nut 3 comprising a tooth pinion 4 having an extending tail piece 5 is mounted on the screw-thread of said starter shaft. At the opposite ends of said thread there 30 is provided abutment stops 13 and 14 for limiting the displacement of the pinion nut on the starter shaft. Resilient means 24 comprising a series of spring washers is interposed between the abutment stop 14 and the forward or leading end of 35 the pinion 4. In this second form of engine starter construction there is provided two diametrically opposite grooves 25 in the tail piece 5, the coil compression spring 9 of the first form of starting device being here replaced by a washer 40 26 having spring segments 27 which alone provide a resilient action and a washer 28 having tenons 29 which are made to conform to the shape of the flanks of the shaft-thread 2.

It is to be noted that the actuation of the 45 washer 28 by the pinion nut takes place due to the fact that the space between the threads of the screw-thread part 2 and the internal threads of the pinion is smaller than the tail piece 5 on which the washer 28 moves.

The operation of this second form of construction is similar to that described above for the first form, the spring washer 25 serving the same purpose as the coil spring 15 and the washers 26 50 having resilient segments 27 and washers 26 serving the same function as the compression coil spring 9.

It is to be understood that the forms of construction are not limited in any way to the details described and illustrated, but are intended to include all modifications, particularly such in which 60 the screw-threaded part 2 of the shaft 1 com-

prises an independent sleeve fixedly secured on the shaft 1.

What I claim as my invention and desire to secure by Letters Patent, is:

1. A starting device for internal combustion 80 engines, including in combination, a one-piece screw-threaded motor-driven shaft, a toothed pinion having an internal screw threaded part mounted with longitudinal play in engagement 85 with said screw-threaded motor-driven shaft, said pinion being adapted to mesh with a gear wheel of an engine fly-wheel, and a resilient element carried by said pinion and positioned to engage a thread of said motor-driven shaft for taking up said longitudinal play. 90

2. The device defined in claim 1 in which said pinion is provided with a tail piece for supporting and guiding said resilient element.

3. A starting device for internal combustion 95 engines comprising in combination, a screw threaded motor-driven shaft, a toothed pinion having an internal screw threaded part mounted with longitudinal play on said motor driven shaft, said pinion being adapted to mesh with the gear 100 wheel of an engine fly wheel, and resilient means extending from said pinion, said pinion being provided with a tail piece having a length greater than the distance separating the opposed flanks of two adjacent screw threads of said shaft and having a slot adapted to guide said resilient 105 means with respect to said pinion.

4. A starting device for internal combustion engines comprising in combination, a screw 110 threaded motor driven shaft, a toothed pinion having an internal screw threaded part mounted with longitudinal play on said motor driven shaft, said pinion being adapted to mesh with the gear 115 wheel of an engine fly wheel, resilient means extending from said pinion, said pinion being provided with a tail piece having a length greater than the distance separating the opposed flanks of two adjacent screw threads of said shaft and having a slot, and means for guiding the resilient 120 means with respect to said pinion, said means including tenons extending to about the flanks of threads of said motor driven shaft.

5. A starting device for internal combustion engines including in combination, a screw-threaded 125 drive shaft, a toothed pinion having an internal screw-threaded part mounted with longitudinal play on said screw-threaded shaft, said pinion being adapted to mesh with a gear-wheel of an engine fly-wheel, and a compression spring carried by the pinion for resiliently taking up said longitudinal play, portions of said spring reacting 130 compressively on the threaded parts of the drive-shaft, said spring being compressible for making the longitudinal play effective when said pinion and gear are in unmeshed contact.

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