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M. B. JACKSON

STARTER FOR INTERNAL COMBUSTION ENGINES

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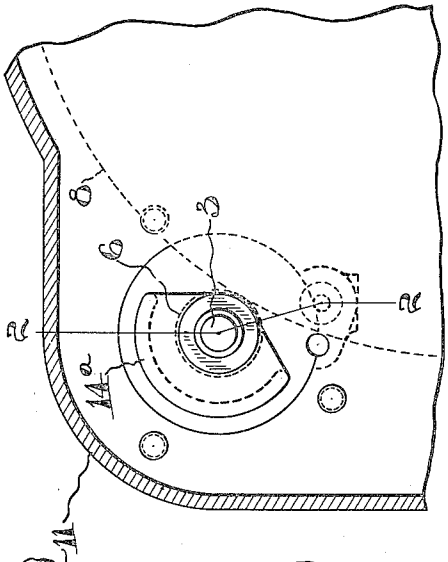


Fig. 1.

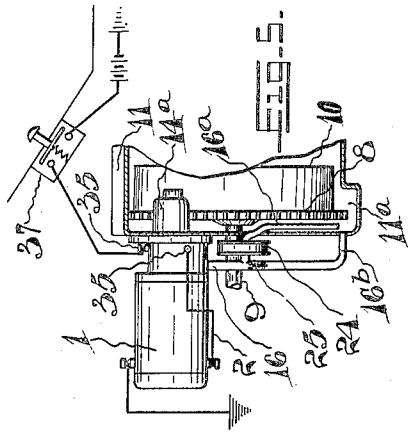


Fig. 5.

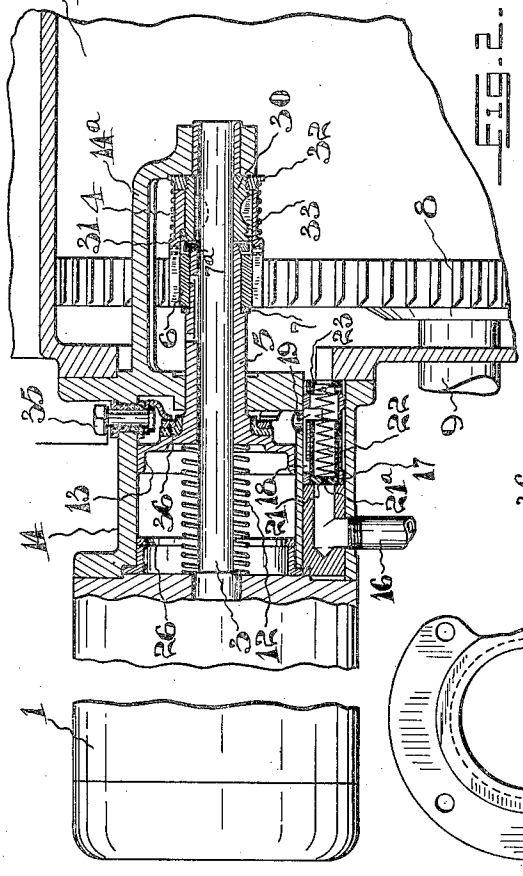


Fig. 2.

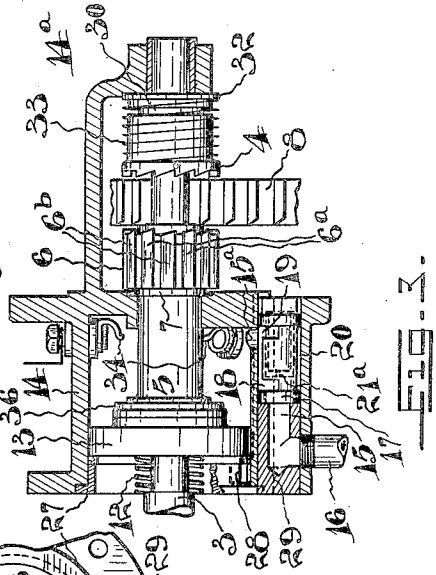


Fig. 3.

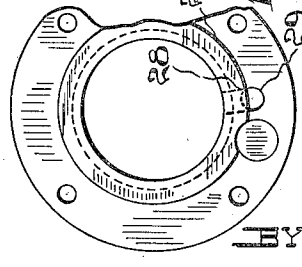


Fig. 4.

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UNITED STATES PATENT OFFICE.

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STARTER FOR INTERNAL-COMBUSTION ENGINES.

Application filed July 23, 1924. Serial No. 727,656.

This invention relates to starters for use with internal combustion engines, and more particularly to that type in which a starter pinion is axially moved into and out of mesh with a gear on the engine. Heretofore these starter pinions have been simultaneously rotated and axially moved so that the pinion, while moving into mesh with the gear, drives the latter, which arrangement has a tendency to cause the teeth of each to be damaged, and my object is to overcome this objectionable feature.

I attain my object by means of a clutch device which forms or breaks the drive connection for the starter pinion after it is entirely meshed with the engine gear or when the pinion is moved out of mesh with the latter respectively.

Further objects I have in mind will hereinafter appear.

This invention is hereinafter more fully described and illustrated in the accompanying drawing in which

Fig. 1 is an end elevation of the starter showing it in position in a casing of an engine, the casing being broken away and shown in cross section;

Fig. 2 a vertical section of the same on the line 2—2 in Fig. 1 showing the parts in their operative positions;

Fig. 3 a section of the starter cylinder taken in the same plane as that shown in Fig. 2 and showing the parts therein in side elevation and in their inoperative positions;

Fig. 4 an end elevation of the cylinder; and

Fig. 5 an assembly view on a small scale illustrating one arrangement for pumping liquid into the starter cylinder and showing a wiring diagram of the starter motor.

In the drawings like numerals of reference indicate corresponding parts in the different figures.

The starter includes an electric motor 1 which is connected by means of the wires 2 with a suitable source of electric supply. The starter shaft 3 is formed as an extension of the motor armature shaft and adjacent the end thereof remote from the motor is keyed, as hereinafter more fully described, a sleeve 4 having ratchet teeth formed therein. On the shaft 3 is slidably mounted a sleeve 5 on one end of which a pinion 6 is journalled. The pinion teeth are slightly extended at the side of the pinion adjacent the ratchet sleeve 4 and these projecting teeth ends are bevelled off to correspond with the ratchet teeth on the sleeve to thus form a drive connection therewith. The pinion 6 is mounted between two shoulders 7 and 7ª formed on or carried by the sleeve 5. These shoulders are spaced apart sufficiently to permit a slight axial movement of the pinion relative to the sleeve 5 for a purpose which will hereinafter appear.

The pinion is adapted to be moved into and out of engagement with the ratchet sleeve 4 and also with a starting gear 8 connected with the crank shaft 9 of an internal combustion engine (not shown). In engines used in automobiles, it is the general practice to form the gear 8 on, or secure it to the part 10 of the clutch which is secured to the crankshaft and acts as a flywheel for the engine. In the drawings the gear 8 is shown within a casing 11 which may be used to also enclose the transmission gearing (not shown). The pinion 6 is normally positioned, by means of a spring 12, in engagement with the ratchet drive sleeve 4 and in mesh with the gear 8. This spring is disposed on the shaft 3 and one end engages the electric motor casing, while the other end engages a plunger 13 formed on or secured to the sleeve 5. The plunger is adapted to reciprocate in a cylinder 14 one end of which is suitably secured to the starter motor and the other end to the casing 11. This cylinder is provided with an arc-shaped extension 14ª which extends within the casing 11 and has a bearing formed on its inner end in which is journalled the inner end of the starter shaft 3.

When the engine is running under its own power, the pinion is axially moved to disengage the drive ratchet sleeve 4 and the gear 8 as follows. A passage 15 formed in the cylinder body and communicating with a fluid pressure supply conduit 16 also communicates by an opening 15ª with the bore of the cylinder adjacent the inner end thereof. The end of this passage remote from the conduit 16 communicates with the casing 11 to permit the fluid to drain thereinto. A tubular open ended valve body 17, tightly fitted in the passage, is provided with inlet and exhaust ports 18 and 19 which communicate, by means of an annular recess 20, with one another and with the opening 15ª. A piston valve 21 slidably mounted in the valve body is adapted to control the ports thereof whereby fluid may be admitted or exhausted

from the cylinder 14. A spring 22 engaging the piston and an annular abutment 23 carried at the inner end of the valve body normally positions the valve to close the inlet port 18 and open the exhaust port 19.

The fluid in the conduit 16 is supplied by a pump 24 which is driven by the crankshaft in any suitable manner. This device is particularly adapted for use with the fluid controlled change speed gearing disclosed in my co-pending application No. 654,160, filed July 27th, 1923, in which instance the fluid conduit 16 will be connected with the main supply conduit thereof and the passage 15 will drain into the casing for enclosing the said gearing. In the drawing of the present application a pumping system is diagrammatically illustrated in Fig. 5 in which the casing 11 is provided with an oil sump 11ª. To the inlet opening of the pump 24 is connected a pipe 16ª and the conduit 16 is connected to the outlet opening of the pump. The conduit communicates, by means of a spill way pipe 16ᵇ, with the oil sump and this communication is normally closed by a safety valve 25, which arrangement prevents any damage to the parts when the engine is running.

The plunger 13 is shaped to provide an annular recess between its inner end and the adjacent end of the cylinder which recess is always in communication with the opening 15ª.

To prevent any fluid which escapes past the plunger and lies in the forward part of the cylinder leaking therefrom, I provide a washer 26, which may be made of felt or similar material, and which is positioned in the outer end of the cylinder by means of a ring 27. This ring is provided with a slot 28 which communicates with a notch, and the latter communicates with a drain outlet 29, both the notch and the outlet being formed in the cylinder 14. The outlet extends towards the inner end of the cylinder and communicates with the interior of the casing 11 so that the oil drained from the outer end of the cylinder passes into the sump 11ª.

Assuming the engine is running under its own power, sufficient pressure of fluid is supplied by the pump to cause the piston valve 21 to be shifted against the pressure of its spring 22 to open the inlet port 18 and close the exhaust port 19. This permits the fluid to shift the plunger 13 against the pressure of its spring 12 to withdraw the pinion 6 from engagement with the ratchet sleeve 4 and the gear 8 as shown in Fig. 3. Immediately after the ignition of the engine is cut off, the pressure of the fluid drops which permits the spring 22 to move the valve piston to close and open the inlet and exhaust ports 18 and 19 respectively. The spring 12 then returns the plunger 13 to its normal position with the pinion in mesh with the gear 8 and contacting against the ratchet teeth of the driving sleeve 4. As the momentum of the flywheel causes the gear to revolve at least a revolution or two after the ignition circuit is broken, the meshing of the gears will take place before the engine comes to a dead stop. It will be noted that as the pinion is journalled on the plunger sleeve 5 that no power is applied thereto while it is being meshed with the gear and thus no damage will be caused to the teeth on the latter.

When it is desired to start the engine the starter motor is energized which causes the ratchet sleeve to be rotated and thus the pinion and the gear. The engine crankshaft is thus rotated, but the gear ratio is such that it is only slowly revolved which is sufficient for starting purposes but not sufficient to cause the pressure of the fluid to shift the valve piston 21 against the pressure of its spring. The instant the crankshaft, and thus the gear 8, is revolved by the engine the pinion 6 is rotated faster than the drive sleeve 4 and the ratchet teeth on the latter cause a slight axial movement of the pinion, the sleeve 5 and the plunger 13 on the shaft 3. Fluid under pressure is then supplied by the pump 24 to overcome the piston valve spring 22 and move the piston valve to open and close the inlet and exhaust ports 18 and 19 respectively. This permits the fluid to actuate the plunger 13 to move the pinion out of mesh with the gear 8. The spacing of the shoulders 7 and 7ª, as hereinbefore described, permits the pinion, when it is only slightly meshing with the gear, to be "kicked" free of the latter.

While the engine is running the fluid from the pump holds the pinion in its inoperative position and when the pressure in the conduit 16 reaches a predetermined maximum the safety valve 25 permits the excess of fluid to flow back into the sump 11ª.

To prevent the possibility of the pinion 6 engaging the ratchet sleeve 4 while the latter is in motion, the former is carried on the starter shaft 3 so that it will be moved axially thereof in engagement with the pinion, and the plunger 13 carries a switch in the starter circuit whereby the starter will not be energized until the plunger has completed its stroke, with the pinion and ratchet sleeve in engagement with one another. This is accomplished by suitably securing a collar 30 to the starter shaft 3, the collar having a shoulder 31 formed on one end and a nut 32 threaded on the other end. The ratchet sleeve is slidably mounted on the collar and is counterbored to form a shoulder adapted to engage the shoulder 31 to limit its movement in one direction. The ratchet sleeve is normally positioned, by means of a spring 33, engaging the nut 32 and the sleeve, in engagement with the shoulder 31.

The inner end of the cylinder 14 carries two contacts 34 formed on or secured in position within the cylinder by means of bolts 35 which pass through the cylinder wall and are suitably insulated therefrom. The inner end of the plunger is provided with a switch ring 36 which is suitably insulated therefrom and is adapted to simultaneously engage the two contacts 34 when the plunger is at the end of its stroke for meshing the pinion 6 with the gear 8 and engaging the former with the ratchet sleeve 4. It will be noted that the spring 33 which is of less strength than the spring 12 normally positions the ratchet sleeve 4 so that it engages the pinion 6, before the latter has reached the end of its inward movement, and travels back in engagement with the sleeve. This inward movement is terminated when the plunger switch ring 36 engages the contacts 34. One of the contacts is connected with a terminal of the starter motor which is grounded on the frame of the vehicle. The other contact 34 is connected with a manually operated switch 37 which is connected with a suitable source of electric energy which is also grounded on the frame.

From this it is evident that should the engine "fire" once or twice and then stop, the pinion 8 will be first disengaged from the ratchet teeth and then partially moved, by the action of the fluid pressure against the plunger 13, away from the ratchet sleeve. This partial movement also breaks the starter circuit and when the engine stops the spring 12 will return the pinion to engage the ratchet sleeve before the latter is again rotated.

What I claim is:—

1. A starter for use with an internal combustion engine and including a starter shaft; an axially movable pinion carried by and normally free from the shaft and adapted to mesh with a starting gear on the said engine; means for forming a drive connection between the shaft and the pinion; means for normally positioning the pinion in mesh with the gear and in engagement with the drive connecting means; and means for moving the pinion out of engagement with the drive connecting means and the gear.

2. A starter for use with an internal combustion engine and including a starter shaft; an axially movable pinion carried by and normally free from the shaft and adapted to mesh with a starting gear on the said engine; means for forming a drive connection between the shaft and the pinion; yielding means for normally positioning the pinion in mesh with the gear and in engagement with the drive connecting means; and means for moving the pinion out of engagement with the drive connecting means and the gear.

3. A starter for use with an internal combustion engine and including a starter shaft; an axially movable pinion carried by and normally free from the shaft and adapted to mesh with a starting gear on the said engine; means for forming a drive connection between the shaft and the pinion; means for normally positioning the pinion in mesh with the gear and in engagement with the drive connecting means; and fluid pressure means for moving the pinion out of engagement with the drive connecting means and the gear.

4. A starter for use with an internal combustion engine and including a starter shaft; an axially movable pinion carried by and normally free from the shaft and adapted to mesh with a starting gear on the said engine; means for forming a drive connection between the shaft and the pinion; yielding means for normally positioning the pinion in mesh with the gear and in engagement with the drive connecting means; and fluid pressure means for moving the pinion out of engagement with the drive connecting means and the gear.

5. A starter for use with an internal combustion engine and including a starter shaft; an axially movable pinion carried by and normally free from the shaft and adapted to mesh with a starting gear on the said engine; ratchet means for forming a drive connection between the shaft and the pinion; means for normally positioning the pinion in mesh with the gear and in engagement with the drive connecting means, the ratchet drive connection being adapted to automatically move the pinion to break the said drive connection when the crank shaft is rotated by the engine; and means for supplying fluid under pressure to continue the movement of the pinion to disengage the gear.

6. A starter for use with an internal combustion engine, the latter having a gear for revolving the crank shaft thereof, an axially movable pinion carried by the starter and adapted to drive the gear; a fluid pressure supply conduit having inlet and exhaust ports; a piston valve slidably mounted in the said conduit and normally adapted to close and open the inlet and exhaust ports respectively, the fluid pressure being adapted to move the valve to open and close the inlet and exhaust ports respectively; and means actuated by the fluid pressure to axially move the pinion relative to the gear.

7. A starter for use with an internal combustion engine and provided with a starter shaft; a cylinder; a plunger for reciprocating in the cylinder and provided with a sleeve freely mounted on the shaft; a pinion journalled on the sleeve and axially movable therewith; means forming a drive connection between the pinion and the shaft; yielding means tending to move the plunger in

one direction; and fluid pressure means connected with the cylinder for moving the plunger in the opposite direction.

8. A starter for use with an internal combustion engine and provided with a starter shaft; a cylinder; a plunger for reciprocating in the cylinder and provided with a sleeve freely mounted on the shaft; a pinion journalled on the sleeve and axially movable therewith, the pinion being adapted to mesh with a starting gear on the said engine; means forming a drive connection between the pinion and the shaft; yielding means tending to move the pinion into mesh with the gear and into engagement with the drive connecting means; and means actuated by the engine for supplying fluid under pressure to the cylinder to move the pinion out of engagement with the drive connecting means and the gear.

9. A starter for use with an internal combustion engine and provided with a starter shaft; a cylinder; a plunger for reciprocating in the cylinder and provided with a sleeve freely mounted on the shaft; a pinion journalled on the sleeve and axially movable therewith, the pinion being adapted to mesh with a starting gear on the said engine; means forming a drive connection between the pinion and the shaft; yielding means tending to move the pinion into mesh with the gear and into engagement with the drive connecting means; a fluid passage formed in the cylinder and having an opening communicating with the bore thereof; a fluid pressure supply conduit connected with the passage; a valve body in the said passage having inlet and exhaust ports communicating with the opposite ends of the passage and with the said opening; and a piston valve slidably mounted in the valve body for controlling the inlet and exhaust ports.

10. The combination with an internal combustion engine provided with a gear for revolving the crankshaft thereof, of starting mechanism including a starter shaft; an axially movable pinion carried by and normally free from the starter shaft and in mesh with the said gear; means for forming a drive connection between the starter shaft and the pinion; and fluid pressure means for moving the pinion out of engagement with the gear when the crank shaft is revolved by the engine.

11. A starter for use with an internal combustion engine and including a motor; speed reducing gearing between the starter motor and the engine shaft including a shaft and a gear loose on the shaft and axially slidable into and out of mesh with another gear wheel; fluid pressure means actuated by the engine tending to slide the movable gear out of engagement with the other gear; a spring tending to press the movable gear into engagement with said other gear; and a clutch adapted to give the movable gear a driving connection with its shaft after it has been moved into mesh with the said other gear.

12. A starter constructed as set forth in claim 9 in which the piston valve is provided with a relief opening.

Signed at Toronto, Canada, this 9th day of July, 1924.

MAUNSELL B. JACKSON.