Feb. 9, 1932. F. H. RAGAN 1,843,987

ENGINE STARTER

Filed May 8, 1931 2 Sheets-Sheet 1

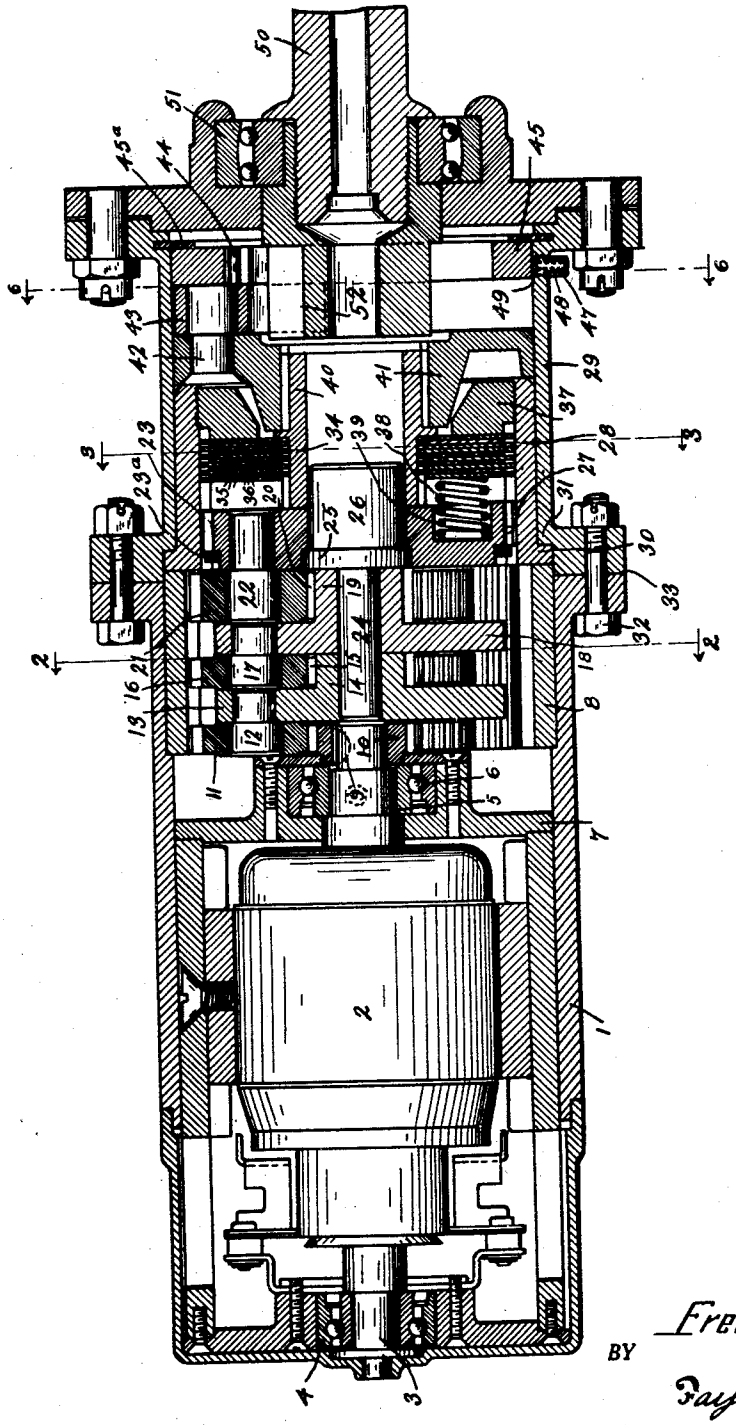


Fig. 1

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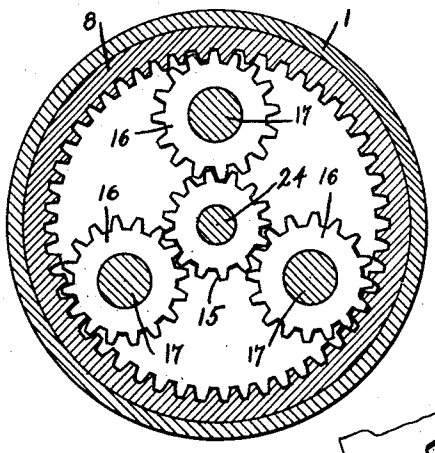


Fig. 2

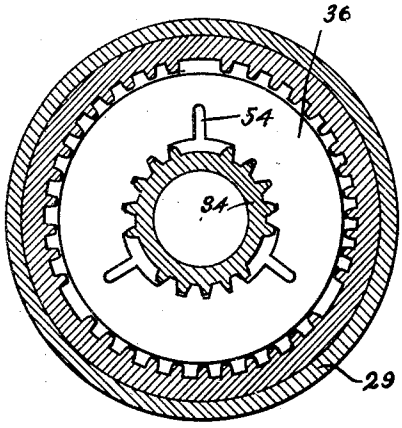


Fig. 3

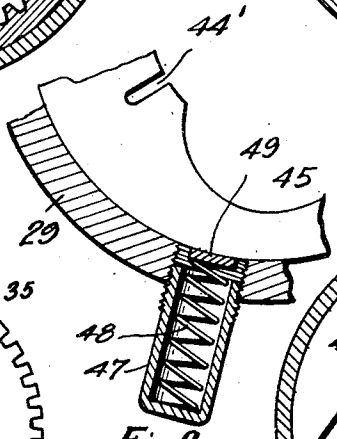


Fig. 8.

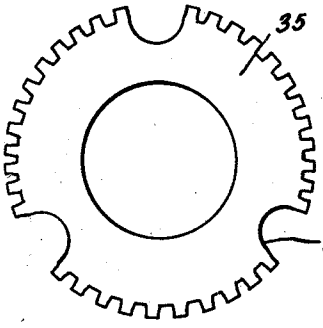


Fig. 4

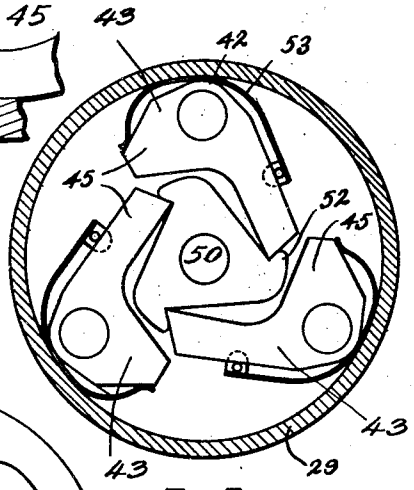


Fig. 6

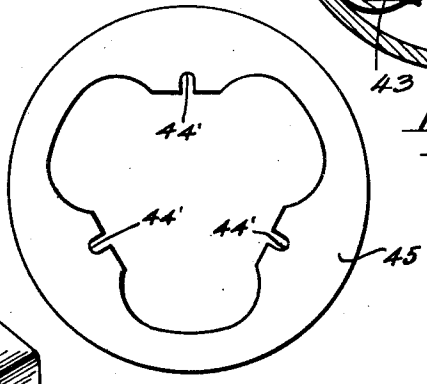


Fig. 7

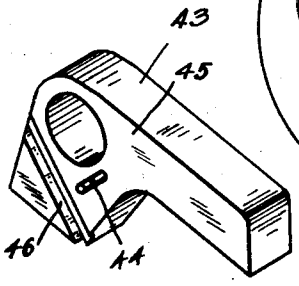


Fig. 5

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Patented Feb. 9, 1932 1,843,987

UNITED STATES PATENT OFFICE

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ENGINE STARTER

Application filed May 3, 1931. Serial No. 535,825.

This invention, relating as indicated to an engine starter, has specific reference to a form of construction which may be employed as the starting means of any common form of internal combustion engine such as is employed as the motive power in land vehicles and aircraft.

It is among the objects of my invention to provide a form of construction which will permit the employment of a high speed, low torque driving motor to produce a low speed, high torque cranking result and a form of construction in which the possibility of damage to the apparatus by backfiring of the engine being started is entirely eliminated. Other objects of my invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention, then consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings:

Fig. 1 is a sectional view of the apparatus comprising my invention; Fig. 2 is a transverse sectional view of the apparatus illustrated in Fig. 1, taken on a plane substantially indicated by the line 2—2; Fig. 3 is a transverse sectional view of the apparatus illustrated in Fig. 1 taken on a plane substantially indicated by the line 3—3; Fig. 4 is an elevational view of one type of clutch plate employed in the assembly illustrated in Fig. 1; Fig. 5 is a perspective view of one of the pawls employed in the assembly illustrated in Fig. 1; Fig. 6 is a transverse sectional view of the apparatus illustrated in Fig. 1, taken on a plane substantially indicated by the line 6—6 but showing an alternative form of construction; Fig. 7 is an elevational view of the friction or inertia ring forming part of the assembly illustrated in Fig. 1, and Fig. 8 is a fragmentary sectional view drawn to an enlarged scale of the means for braking the pawl actuating member illustrated in Figs. 1 and 7.

Referring now more specifically to the drawings and more especially to Fig. 1, the apparatus comprising my invention consists of a casing 1 which has supported therein a motor 2, which may be of any common form of electric motor usually employed for starting purposes, that, is, preferably a high speed, low torque motor. The one end 3 of the armature shaft of the motor is journaled in suitable bearings 4 carried by one end of the casing 1 and the other projecting portion 5 of such armature shaft is journaled in bearings 6 carried by an abutment member 7, likewise supported in the casing 1.

The casing 1 has non-rotatably supported therein an orbit gear 8 which is in the form of a barrel provided on its inner periphery with teeth and this orbit gear forms one element of the speed reducing means now to be explained.

The speed reducing means by which the high speed, low torque of the motor shaft is converted into a low speed, high torque cranking power, is preferably a triple planetary system which may be described as follows:

Secured to the shaft 5 of the motor 2 by means of a key 9 is a pinion 10 which meshes with three planetary gears 11, which, in turn, mesh with the orbit gear 8. The planet gears 11 are supported on stub shafts 12 carried by a spider 13 which has a hub 14 associated therewith and extending axially therefrom. The hub 14 has gear teeth 15 formed thereon which mesh with the next set of planet gears 16 which also mesh with the orbit gear 8. The planet gears 16 are rotatably supported on stub shafts 17 which are carried by a spider 18 which has a hub 19 associated therewith and extending axially therefrom. The hub 19 has gear teeth 20 formed thereon which mesh with the planet gears 21 in the last stage of the gear reduction. Planet gears 21 are rotatably supported on shafts 22 which are secured to a plate 23. The spiders 13 and 18 and the plate 23 are rotatably supported on a pilot shaft which has a reduced portion 24 in en-

gagement with the spiders 13 and 18, an annular enlarged portion 25 bearing between the plate 23 and the pinions 21 and an enlarged portion 26 bearing on the inner periphery of the plate 23.

The plate 23 is provided with splines 27 on its outer periphery, which splines engage the splined inner periphery of a substantially tubular member 28. The plate 23 is secured against axial movement in one direction by means of a snap ring 23*a* positioned in a groove on the inner periphery of the member 28. The tubular member 28 is rotatably supported on the inner periphery of the casing 29 and has an annular flange 30 which, engaging a shoulder 31, prevents relative axial movement between the member 28 and the casing 29. The casing 1 and 29 are maintained in assembled relation by bolts such as 32 cooperating with flanges 33.

Mounted coaxially with the member 28 is an externally splined sleeve 34 which, at one end, is telescopically engaged by the member 26. A plurality of clutch plates 35 formed in the manner hereinafter more fully explained and provided with serrated outer peripheries, are also mounted coaxially with the member 28 and with such outer peripheries engaged by the splines on the inner periphery of such member 28. A second set of plates 36 arranged alternately with the plates 35 formed in the manner hereinafter more fully explained and provided with serrations on their inner peripheries are mounted on the splined member 34. These plates are maintained in intimate contact by an annular nut 37 threadedly engaged by the inner periphery of the terminal of the member 28. This nut 37 forces the plates 35 and 36 into intimate contact and against a plurality of compression springs 38 which, at their rear ends, bear against the plates 23. Any desired number of springs such as 38 may be employed at circumferentially spaced points between the plate 23 and the clutch plates, although six of such springs, it is believed, will be found sufficient. The springs 38 are positioned on the plate 23 by means of counterbores 39 which may be formed in such plate intermediately of the points where the stub shafts 22 are secured thereto. To the forward end 40 of the externally splined member 34 is secured an annular internally splined member 41 which carries a plurality of circumferentially spaced stub shafts 42 which project axially therefrom and on which are oscillatably mounted pawls 43. The pawls 43 are preferably in the form most clearly illustrated in Figs. 5 and 6 for the purpose hereinafter more fully explained.

The pawls 43 have pins 44 projecting laterally therefrom, which pins extend into slots 44′ formed on the inner periphery of an inertia or friction ring 45. The ring 45 is maintained against axial movement in one direction by means of a snap ring 45*a* engaged in a groove on the inner periphery of the casing 29. Instead of having the pins 44 secured to the pawls 43, I may prefer to secure such pins in the ring 45 and then provide slots such as 46 in the face of the pawls 43 into which these pins extend.

The casing 29 may have a threaded aperture formed in the wall thereof adjacent the forward end in which is threadably engaged a screw cap 47 which maintains a compression spring 48 into contact with a friction block 49 engaging the outer periphery of the ring 45.

The shaft 50 of the internal combustion engine which is to be cranked is journaled in a bearing 51 mounted in the forward end of the casing 29. The shaft 50 has a ratchet member 52 secured to the terminal thereof, which ratchet member will cooperate with the pawls 43 during the period when the engine is being cranked.

Assuming that the pawls 43 are out of engagement with the ratchet 52 on the end of the crankshaft 50 and such crankshaft is to be cranked, the motor 2 will be energized by means of a suitable switch so as to cause a rotation of its shaft 5. The shaft 5 will, therefore, rotate the pinion 10, which is keyed thereto and this pinion will cause a rotation of the planet gears 11. Rotation of the planet gears 11 will cause the same to roll around the orbit gear 8 and carry with them the spider 13 due to the fact that the stub shafts 12 on which the planet gears 11 are mounted are carried by this spider 13. The spider 13, that is, the sun gear 15 carried by the hub thereof, will rotate at a considerable reduction in speed from the rotation of the shaft 5. The sun gear 15, upon rotation, will cause a rotation of the planet gears 16 which will also be caused to roll around within the orbit gear 8. Planet gears 16 will, through the stub shafts 17, cause a rotation of the spider 18 and consequently, the sun gear 20. The sun gear 20, upon rotation, will cause rotation of the planet gears 21 which will roll around the inner periphery of the orbit gear 8. The planet gears 21, in moving in their orbit, carry with them the stub shafts 22 and consequently, produce a rotation of the plate 23 carrying such stub shafts.

The plate 23, being splined to the tubular member 28, will cause a rotation of this member. Due to the frictional resistance between the intimately contacting plates 35 and 36, rotation of the barrel or tubular member 28 will cause a like rotation of the splined sleeve 34. The splined sleeve 34, through its externally splined terminal portion 40, will cause a rotation of the annular member 41. The annular member 41 carrying the stub shafts 42 on which the pawls 43

are oscillatably supported, will cause a circumferential movement of such pawls.

When circumferential movement of the pawls 43 occurs, the drag of the ring member 45 which is occasioned either by its own inertia or by the braking effect of the spring 48, will cause such pawls to rotate on the stub shafts 42 until the terminal portions of the pawls are brought into engagement with the teeth of the ratchet 52. Further rotation of the annular member 41 will, therefore, effect a rotation or cranking of the crankshaft 50.

By properly, axially adjusting the annular nut 37 relatively to the tubular member 28, the frictional resistance between the plates 35 and 36 may be accurately adjusted. Any overloading over the adjustable value of such friction between the slip or clutch plates will, therefore, cause relative movement between the barrel 28 and the splined member 34 without doing any damage to the other parts of the apparatus.

Similarly, should the engine backfire when the pawls 43 are in engagement with the ratchet 52, the slip plates 35 and 36 will move relatively to each other and thereby prevent damage either to the triple planetary gear reduction unit or the motor associated therewith.

As hereinbefore explained, instead of the connection between the pawls 43 and the inertia ring 45 comprising a pin 44 secured to and mounted on the pawls and in engagement with such ring, I may provide the ring with a pin which directed toward the pawls will lie in a groove 46 provided therefor in such pawls so that as the pawls begin moving in their orbit, the inertia or braking effect of the ring 45 will cause the pawls to rotate on their supporting shafts until engagement is effected with the ratchet. As soon as the engine begins to turn over so that the rotation of the crankshaft 50 exceeds the rotation of the splined member 34, the ratchet teeth will throw the pawls outwardly, overcoming the inertia or friction of the ring 45 but as soon as the pawls are thrown outwardly, such ring will maintain the same in disengaged relation with the ratchet until the motor 2 is again energized. This form of construction, therefore, is effective to, at all times, maintain the starter and the crankshaft disconnected unless the starter mechanism is driven by the starter motor.

Another means for effecting rotation of the pawls 43 on their stub shafts 42 may be constructed, as is most clearly illustrated in Fig. 6. In this figure, the pawls have associated therewith springs 53 which, engaging the pawls on opposite sides of their supporting shafts 42 and also in engagement with the inner periphery of the casing 29 will, when the shaft 42 is caused to move in a circle, cause engagement or disengagement between the pawls and the ratchet depending upon the direction of rotation of such shaft.

It will be noted that this alternative form of construction might well be incorporated with the form of construction illustrated in Fig. 1 so that the effect of the inertia ring 45 may be supplemented by the action of the springs 53 in bringing about an engagement and disengagement between the pawls and the ratchet carried by the end of the crankshaft.

In order that the plates 35 and 36 may be set to release at a given torque and in order to insure that such value will not change readily after several backfires or slippages between the plates which usually results in a burning or similar scoring of the contacting faces of the plates, I propose to provide a plurality of radially extending slots or grooves 54 extending radially from the inner periphery of the plates 36 and a plurality of grooves 55 extending radially inwardly from the outer periphery of the plates 35. In order to insure that the oil may have ready access to these grooves, I propose to omit the splines on the outer periphery of the member 34 in the area from which the grooves 54 emanate, as most clearly illustrated in Fig. 3, so that the oil may pass axially of the member 34 into the grooves 54 where the centrifugal force incidental to the rotation of the plates 35 and 36 will cause the oil to flow readily and properly lubricate the contacting faces of the adjacent plates. If desired and for certain types of installation it may be necessary, to similarly omit the splines on the inner periphery of the tubular member 28 in the areas of the grooves 55 in the plates 35, so that the oil may likewise have ready access to the contacting faces of the plates so that when such plates are once set to release at a given torque value, such value will not materially change even after repeated clutch slippages.

It is believed that the further advantages of the hereinbefore described form of starter construction will be so apparent to those familiar with the art that an enumeration thereof, at this point, is unnecessary.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In an engine starting mechanism, the combination of a driving motor, speed reducing means between said driving motor and the shaft to be cranked, a torque overload release clutch between said speed reducing means and said shaft, a ratchet on said shaft, pawls associated with said starting mecha-

nism for engagement with said ratchet and frictionally braked inertia means responsive to rotation of said motor for moving said pawls into engagement with said ratchet.

2. In an engine starting mechanism, the combination of driving means for the shaft to be cranked, and means for establishing unidirectional driving communication between said driving means and said shaft, said means consisting of a ratchet on said shaft, a plurality of pawls oscillatably secured to said driving means, and an inertia member in engagement with each of said pawls for moving said pawls into engagement with said ratchet upon cranking rotation of said driving means.

3. In an engine starting mechanism, the combination of driving means for the shaft to be cranked, and means for establishing unidirectional driving communication between said driving means and said shaft, said means consisting of a ratchet on said shaft, a plurality of pawls oscillatably secured to said driving means, a member in engagement with each of said pawls, and means for braking said member against rotation to move said pawls into engagement with said ratchet.

4. In an engine starting mechanism, the combination of driving means for the shaft to be cranked, a ratchet on said shaft, a plurality of pawls oscillatably supported on said driving means for movement in a plane normal to the axis of said shaft into and out of engagement with said ratchet, a pawl actuating member mounted concentric with said shaft and in engagement with said pawls, and means for braking said actuating member against rotation.

5. In an engine starting mechanism, the combination of driving means for the shaft to be cranked, a plurality of pawls oscillatably supported on said driving means, a ratchet on said shaft, an annular member adjacent said pawls, pins oscillatably interconnecting said pawls and said annular member, and means for braking the rotation of said annular member upon cranking rotation of said driving means to move said pawls into engagement with said ratchet.

Signed by me this 4th day of May, 1931.

FRED H. RAGAN.